Science Field Shops: the first step in creating an improved extension service in Indonesia, centred around agrometeorological learning.

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Cover Photo:
'*Omplong*' and resting house in Mas Chandra's field. Sumbon, Indramayu.
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Chapter 1. Climate change adaptation: why is there a need to increase the adaptive capacity of (smallholder) farmers in Indonesia?

The most recent Intergovernmental Panel on Climate Change (IPCC) report, it was stated that it is 95% certain that 50% of climate change is from anthropogenic sources (Alexander et al., 2013). The closest the IPCC has ever come to stating that anthropogenic climate change ***is*** a reality. A lot of previous policies have been on mitigating the effects of climate change, while in the recent years there has been a move to implementing more policies concerning themselves with climate change adaptation (Schipper, 2006). The implementation of the Climate Field Schools by the Indonesian government (Siregar and Crane, 2011;Winarto et al., 2008), and the sub-sequential response of the Science Field Shop (SFS) approach (Stigter and Winarto, 2013; Winarto and Stigter, 2011), is a reflection of this trend. These two approaches aim at increasing the farmers adaptive capacity to climate change, through opening up avenues for farmers to understand and undertake, adaptation processes. The CFSs are schools which are 13 weeks long, and follow a linear, top-down teaching module, while the SFSs are a long-term, currently of indeterminate length, approach, which moves away from the traditional, linear style of teaching. The SFS revolves around collaborative research between farmers and scientists on agrometeorological topics, which aims at increasing the adaptive capacity of farmers to seasonal climate variability, while on the other hand increasing the efficacy of applied science through feedback from field experiences. The need to adapt practices is thus seen as not only for farmers, but also for scientists to adapt their practices in order to provide a service to aid the farmers in adapting to climate change. An essential part of both the SFSs and CFSs is providing a seasonal climate forecast, which in the CFS was a yearly publication of a report distributed to the farmers, while in the SFS approach a monthly update of a three month forecast transmitted to famers via a network of text messages. This forecast is an aspect of how the SFS approach aims to increase the farmers adaptive capacity to climate change, by providing a space to discuss the forecast in order for it to become a service, rather than a transmission of information.

The SFS approach is an alternative to the CFSs, and actually comes closer to the notions of the Farmer Field Schools (FFSs), of which the CFS name is derived from. The SFS approach is currently being implemented in Indramayu, a region in West Java, Indonesia, and the results of this study is being incorporated into updated conceptualisations of the SFSs (Stigter and Winarto, 2013; Winarto and Stigter, 2011). The SFSs will later be implemented in other regions of Indonesia, as part of a wider National Network for Rural Response to Climate Change (NNRRCC). Due to the long-term vision of the SFS in Indramayu, it is clear that the collaboration is in its early stages, yet provides important learning points in order to facilitate the implementation of the NNRRCC. Before delving into the ins and outs of the SFSs, and the dynamics that are emerging in Indramayu (Chapter 2), this chapter will outline and define the climatological concepts used in this thesis and highlight various reasons why climate change is an issue for (smallholder) farmers in Indonesia. Adaptation, adaptive capacity, and vulnerability are terms that have been used in various disciplines, with varying definitions and connotations, and by making it clear from the very start of this thesis, it will hopefully avoid any misunderstanding about the use of these terms. Highlighting the various impacts of climate change, and the need to adapt to a number of these impacts, begins to highlight the justification of this thesis and to which field within the climate change adaptation literature this thesis aims to contribute. Furthermore, this chapter will outline the problem statement, the research objectives and the research questions that this thesis has tried to answer through the data that has been collected in the field in Indramayu.

Climate Change Adaptation as a research frame and concept

Adaptation at its simplest is “a process of deliberate change in anticipation of or in reaction to external stimuli and stress” (Nelson et al., 2007:395). Yet adaptation as a concept has a wide history in various disciplines, where it was originally used in the biophysical sciences, especially evolutionary biology, where “it broadly refers to the development of genetic or behavioral characteristics which enable organisms or systems to cope with environmental changes in order to survive and reproduce” (Smit and Wandel, 2006). Smit and Wandel (2006) discuss the different definitions of adaptation within different disciplines, within the scope of human and human-environment systems. From this analysis it becomes clear that there is a relatively large diversity of definitions, which Smit and Wandel (2006) note are both used implicitly and explicitly, and that disciplines seem to adapt the simple definition given above to fit the scope of their research. In this sense adaptation in the climate change context may be discussed and analysed by economists as changes in economic strategies (e.g. Stage, 2010), by anthropologists as changes in cultural practices (e.g. Crane, 2010; Roncoli et al., 2009), by agronomists as changes in agriculture decision making (e.g. Thornton et al., 2010), and so on. The different focusses of adaptation are shaped by the scientists respective backgrounds and interests. Aside from the different focus in terms of context, there are different levels and methods of analysis of adaptation.

Broad scale analysis invariably looks at the possible impacts of climate change through modelling, with the possibility of incorporating hypothetical adaptation strategies. The aim is to estimate the damage due to climate change, and to estimate to what extent the adaptation strategies employed could mitigate the damage done. Another method of climate change adaptation moves to a smaller scale, where more specific adaptation options are chosen based on their applicability to a specific system (e.g. Thornton et al., 2010). The adaptations are then ranked or rated through analysis according to various variables, such as "benefits, costs, implementability, effectiveness, efficiency, and equity" (Smit and Wandel, 2006:284). Another branch of analysis focusses on vulnerability or adaptive capacity as an analytical lense, comparing various communities, countries or regions through their relative adaptive capacity or vulnerability. The variables that are compared are normally chosen on the basis of the scientists own preferences. This comparison is done to analyse which area is the most vulnerable (as they may have a relatively low adaptive capacity) and has the highest need for adaptation to take place. The problem with this last form of analysis is that the causes of the vulnerabilities and adaptive capacity are not investigated, and that they are accepted as present. This is done within the previous two methods of analysis, yet they are flawed in the sense that they assume within the models that proposed adaptations will be implemented without question. This is also the case with policy recommendations based on the vulnerability and adaptive capacity assessments, as these recommendations are given with the assumption that the more vulnerable areas will be the focus of adaptation initiatives (Smit and Wandel, 2006). The final type of analysis Smit and Wandel (2006) discuss, is the “practical application” (Smit and Wandel: 285) approach, to which this thesis aims to contribute. The practical application approach moves away from scenario based modelling, and goes into the community or region to identify the adaptive capacity and possible adaptation strategies through empirical research. Through analysis of the vulnerability or indeed adaptive capacity within the practices and decision making processes 'in the field', adaptation possibilities that could fit these practices and processes are identified. This method thus leans towards a more 'bottom-up' approach, versus the 'top-down' orientation of the scenario based methods of analysis (Smit and Wandel, 2006). It is not suggested in this thesis that the "practical application" approach is necessarily the *best* approach, and that the other modelling and criteria based approaches should be neglected, yet it does however, provide a better picture of

the adaptations made to practices, which is the focus of this thesis in terms of the use adaptation. The one slightly restrictive aspect of this thesis on adaptation, is that it cannot go into depth into the various scales, from individual to governmental and international level, that influence adaptation processes (Adger et al., 2005).

Adaptation, and indeed adaptive capacity and vulnerability, are concepts that are defined and used in various diverging disciplines. The possibility is that this will make the use of them problematic due to the confusion it can instigate, yet it can also be used as a 'boundary object' which "provides a common point of reference, a touchstone that can actively promote communication between participants through its ability to create compatible conceptual frames" (Lynch et al., 2008:170). The various frames applied to the adaptation concept can thus prove to be complementary to one another, thus the concept can be used as a promoter of interdisciplinary research. Although this thesis does not go any further in analysing adaptation as a boundary object, it does take the first step necessary to avoid confusion by making the implicit understanding of adaptation by the author explicit. This does not only let the reader understand the perspective of the thesis on adaptation, but also helps shape the analysis of adaptation and adaptive capacity of the practices within the SFS case study in Indramayu. Adapting the simple definition of adaptation given by Nelson et al. (2007:395) given above to fit the confines of this thesis, adaptation is defined as a process of deliberate change in farming practices or decision making in anticipation of probable, or in reaction to occurring, changes in long term and short term climate. To unpack this even further, climate change impacts mainly refers to the climate variability experienced through rainfall fluctuations. Other changes such as increased occurrence of pests and diseases may be considered. Climate change is the focus of the adaptation research, yet attributing certain changes in the socioecological environment to climate change remains a challenge.

Adaptation: Introducing adaptive capacity and vulnerability

Adaptation is also closely linked with the concepts of adaptive capacity and vulnerability, which can also be seen as reflections of one another. Smit and Wandel (2006) synthesise this as succinctly as "adaptations are manifestations of adaptive capacity, and they represent ways of reducing vulnerability" (Smit and Wandel, 2006:286). Vulnerability is defined here as "the susceptibility of a system to disturbances, determined by exposure to perturbations, sensitivity to perturbations and the capacity to adapt" (Nelson et al., 2007:396), within which it is clear that alongside adaptive capacity, the concepts of exposure and sensitivity are analysing vulnerability. Exposure relates to the which impacts, and for how long, the practices are exposed to, while sensitivity is denotes how large or small the impact is as a result of the exposure to, in this case, climate related impact. Adaptive capacity is defined as "the preconditions necessary to enable adaptation, including social and physical elements, and the ability to mobilize these elements" (Nelson et al., 2007:397). Adaptation can thus be a reflection of the adaptive capacity of the practices, when analysing a system to identify occuring or historical adaptation processes, while on the other hand adaptive capacity give an indication on how practices can adapt to possible future impacts. The extent of these future impacts (of e.g. climate change) is reflected in the vulnerability of the system.

Within the scope of this thesis, adaptations are researched as ongoing processes, while adaptive capacity is not something that is researched explicitly within this thesis but is seen as the goal of the SFS approach. Vulnerability of the various practices is also described, but mainly to highlight the driver behind adaptations (or the need for adaptations). As highlighted above this thesis aims to contribute to the 'practical application' branch of adaptation research, and implementing a practices orientated approach to analysing adaptations and adaptive capacity.

Adaptation processes (or lack thereof) that are already taking place among the farmers within the SFS case study in Indramayu will be documented and analysed. These adaptation processes will be researched in correlation with the co-production of knowledge in the SFS, and to what extent the collaborative research had a part to play in the implementation of the adaptation processes. Nelson et al. (2007) addresses where adaptation ends, and transformation begins, by adding "without undergoing significant changes in function, structural identity, or feedbacks" within their definition of adaptation. Within this thesis a transformation is when a farmer decides to stop doing agriculture altogether, while an adaptation is when it stays within the scope of agricultural practices. This means that more drastic measures such as changes from rice farming to aquaculture could still be seen as adaptations, which takes a broader look at where adaptation ends and transformation starts than that of Nelson et al. (2007).

Increasing the usefulness of climate change forecasts

One of the ways in which science is trying to help farmers to adapt to climate change, is by providing climate change modelling information through short-term and long-term climate forecasts. In theory it looks promising, yet it does not necessarily work out as planned (See among others: Roncoli et al., 2002; Siregar and Crane, 2011). Roncoli (2006) has written an extensive overview of the ethnographic and participatory methods in understanding how farmers respond to climate change forecasts. Local perceptions and understanding on what climate change is, is one of the ways in understanding how the forecasts will be perceived and understood by the recipients. Indigenous knowledge can also be a great asset in the dissemination of climate change forecasts (Orlove et al., 2010). One of the main points Roncoli (2006) makes is the fact that "the 'technology adoption' paradigm [...] still informs many of its research questions" (Roncoli, 2006:94). Thus rather than seeing the forecasts that result from these models as something that needs to be adopted by the farmers, and finding the best ways of getting the farmers to listen to the information, research should rather focus on understanding the farmers perception on climate change, the vulnerabilities they have in light of climate change and then assessing how research can help improve the farmer's adaptive capacity in coping with these vulnerabilities. Rather than adoption of the climate change forecast by farmers as an outcome, it should be seen as a possible part of a wider solution to help improve the farmers adaptive capacity. Although such methods are making inroads into the social aspects connected to applied climate change research, they are far from perfect and should not be seen as something to replace the model-orientated climate change research. A combination of both the qualitative and quantitative research into the impacts of climate change is needed. Short-term research, both qualitative and quantitative, only scratches the surface of a complex issue such as the relationship between farmers and their social and natural environment and a longer term, "sustained interaction" (Roncoli, 2006:93) is necessary. Within the SFS approach, there is also a simple climate forecast that is being communicated to the farmers, which forecasts the rainfall variability for the upcoming three months. Aside from gaining access to the forecast, the farmers carry out their own research by collecting rainfall data and making field observations, and the results and forecast are discussed with other farmers and the scientists at monthly meetings. Scientists aim to use the knowledge gained from their interaction with these farmers in improving their own, applied research to help understand the farmers vulnerabilities and help them improve their adaptive capacity. The SFS approach is thus creating a space for dialogue between scientists, farmers and, in the future, extension intermediaries, which aims to continue on the long-term.

Agriculture as performance

Crane et al. (2011) stress the need to also look at agriculture through the notion of 'agriculture as performance' in order for climate change adaptation to take place. This is proposed alongside the more technocentric approaches, advocating the need for technologies such as the climate forecasts based on models in order to adapt, and the policy approaches that address the bureaucratic constraints that hinder climate change adaptation. The notion of 'agriculture as performance', was originally proposed by Richards (1989), and discussed form a climate change adaptation perspective by Crane et al. (2011). An example of what is meant by performance is taken from observations in the field in Indramayu, where farmers try to prevent adverse affects of flooding by ensuring that the rice plants are old enough to survive in high levels of water. The planning process of trying to plant the rice in time as part of the farming design. Yet when the flooding is too severe and or if the planting is not done in time, transplanting from other paddy plants or buying more seeds and starting the process again is not necessarily part of this design. Richards proposes this last process is a result of the farmers skill and in turn his 'performance'. This understanding of agriculture as performance, is that farming is not necessarily a pre-designed plan coming to fruition, but one where adversity causes farmers to think on their feet. This theory of 'performance' is underpinned by the three principles of practice theory discussed in Chapter 3, as the analysis through these principles help highlight the driving forces behind the performance. Crane et al. (2011) discuss the importance of 'agriculture as performance' in terms of climate change adaptation and note that modelling approaches within climate change science fail to incorporate such notions of performance, yet at the same time combining the modelling approaches with those that take socially embedded practices is not an easy task. Farmers do not only farm, they are also part of a wider community, which mean they have social responsibilities that may impact their on-farm activities, and in turn their performance. Some of the findings done by Siregar and Crane (2011) indicated that farmers' decision making does not only consider the individual on-farm decisions, but the wider decisions made on a community basis. This is highlighted in Crane et al. (2011), as they state that "the social spaces and processes within which technical agricultural practices are embedded affect how they are enacted" (Crane et al., 2011:180). Thus the wider social networks and culture the farmers live in are an integral part of their farming practices. Following this line of agriculture as performance, the definition of adaptation in this thesis then moves to incorporate the notion of agricultural practices, and understands "adaptation as an on-going and organic process embedded within agrarian communities" (Crane et al., 2011:184).

Indonesia and Climate Change: an indication of the various vulnerabilities

Adaptation has so far been discussed with the assumption that it is clear why it is necessary, and the possible impacts of climate change in the context of Indonesia have not been addressed. This section aims to address this gap, by giving a simple overview of the climate in Indonesia and how it is changing in order to highlight various impacts climate change will have in Indonesia. Indonesia is on the western side of the Pacific Ocean, of which the fluctuation in temperature of the surface water influences the El Niño Southern Oscillation (ENSO). The oscillation refers to a cycle where the season can be normal, in state of El Niño or in the opposite state of La Niña. El Niño normally results in prolonged periods of drought, while La Niña results in large amounts of rain normally resulting in floods. Models are getting increasingly more accurate in predicting the fluctuations in the ENSO system, although the regularity in which the ENSO oscillates has diminished due to the impact of climate change. One of the institutes regularly monitoring the

dynamics of the ENSO system is the National Oceanic and Atmospheric Administration (NOAA) in the United States of America. Via their website, http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/enso_advisory/index.shtml, they publish an update each month on the forecast on the state of the ENSO system. This information could provide to be valuable by the farmers, as knowing when they are facing a year with drought or flooding can help them prepare for the season by changing varieties of rice, timing of planting and even more drastic, changes in crops (although shown in Siregar and Crane (2011) to be less likely). The higher variability within the ENSO system is also coupled with a general trend in rainfall variability and warming, while in areas close to the coast the sea level rise will encroach land and there will be higher salinity (Philippine Rice Research Institute, 2011; Sari et al., 2007). This is also the case in Indramayu, the regency in Indonesia where this study took place, where one of the farmers interviewed is shrimp farming in a field that was once used for growing rice, who also stated other shrimp farms in the area have the same history. Climate change could also increase the prevalence of diseases and pests in the area (Philippine Rice Research Institute, 2011; Sari et al., 2007). All of these impacts will cause strains on the farmers in Indonesia. The apparent failings of the existing extension service, the lack of institutionalisation of the Farmer Field Schools (FFS) and failure of the government run Climate Field Schools (CFS) to help increase the adaptive capacity of the farmers, have prompted the conceptualisation of the SFSs with the aim of doing exactly that.

Problem Statement

The Science Field Shops (SFSs) are a new approach in creating an improved agricultural extension service in Indonesia, using participatory learning methods to increase the rural response to climate change. The approach being advocated aims to increase adaptive capacity of the smallholder farmers and increase the efficacy of the applied research by scientists. What is sometimes forgotten in researching participatory approaches is the role of the scientists and policymakers within the project. This thesis aims to understand how both the scientists and farmers are participating in the co-production of knowledge and adapting their practices, as well as looking into how framing of this co-production of knowledge by the participating actors is influencing the implementation of the SFS approach.

Research Objectives

The instigation of the co-production of knowledge between the scientists and the farmers in Indramayu, has created a novel network connecting farmers and scientists alike. The research the farmers and scientists are participating in aims at increasing the knowledge on the vulnerabilities the farmers have in light of climate change, and in turn increasing the adaptive capacity of the farmers to these vulnerabilities. On the other side of this co-production of knowledge are the scientists, where the aim is to adapt their scientific practices to become better applied. This thesis aims to understand how the network that exists within SFS in Indramayu has thus far influenced the practices of the various actors involved, with a focus on an increase in adaptive capacity of the farmers involved.

The first objective is to document and describe the practices of the actors involved, as a baseline for further analysis. The next objective is understanding the dynamics of the co-production of knowledge and how the actors are socially organising themselves within the SFS. Another objective is to see how the farmers and scientists interact with the wider community, and how interaction with these various actors influence the work done within the SFS. Understanding the actors involved frame the SFS shop to the wider community, and how their perceptions of their

work within the SFS helps shape both their participation in the co-production of knowledge and the implementation of the SFS in Indramayu, is the final objective of this thesis.

These various objectives build up to how participation (and indeed the wider network) is influencing the practices of the actors involved, and in a more specific sense, how the participation by the farmers within the SFS is facilitating adaptation to climate change. The analysis of the adaption will be focussed on processes, both reactive and anticipatory, that are seen as adapting practices to climate variability and events, as well as adaptation processes that are happening within scientific practices in order to aid the adaptation of the farmers.

Main Research Question

How does the network that is created by the Science Field Shops result in adaptation of practices by the actors involved?

Sub-research questions

- How are actors socially organising themselves around and within the Science Field Shops?
- How are the scientists and farmers participating within, and contributing to, the co-production of knowledge that is central to the Science Field Shops approach?
- How do networks in other institutions, such as universities, families and irrigation systems, interact with the Science Field Shops?
- How do the various actors perceive their participation in the co-production of knowledge and how is it framed towards the wider, international community?

Theory, data and discussions

Chapter 2 gives the necessary background information needed to understand how the SFS in Indramayu, Indonesia has taken shape as well giving an indication to the culture in Indramayu. After this introduction the chapter delineates the sampling and methodology done in collecting the data for this thesis. **Chapter 3** discusses the theory that underpins this thesis, before **Chapter 4** moves to describing the farming practices in Indramayu, the vulnerabilities they are facing and the adaptations they are making to these practices. It also touches on the scientific practices of the team of scientists and the adaptations they are making, and the institutions that all the actors in the co-production of knowledge interact with and how they influence the various practices undertaken. **Chapter 5** describes the dynamics of the co-production of knowledge and how the actors are socially organising themselves within the SFS in Indramayu. **Chapter 6** concerns itself with the question surrounding the framing of the collaboration, before **Chapter 7** moves on to discussing the data presented and concluding with how these answer the research questions stated above.

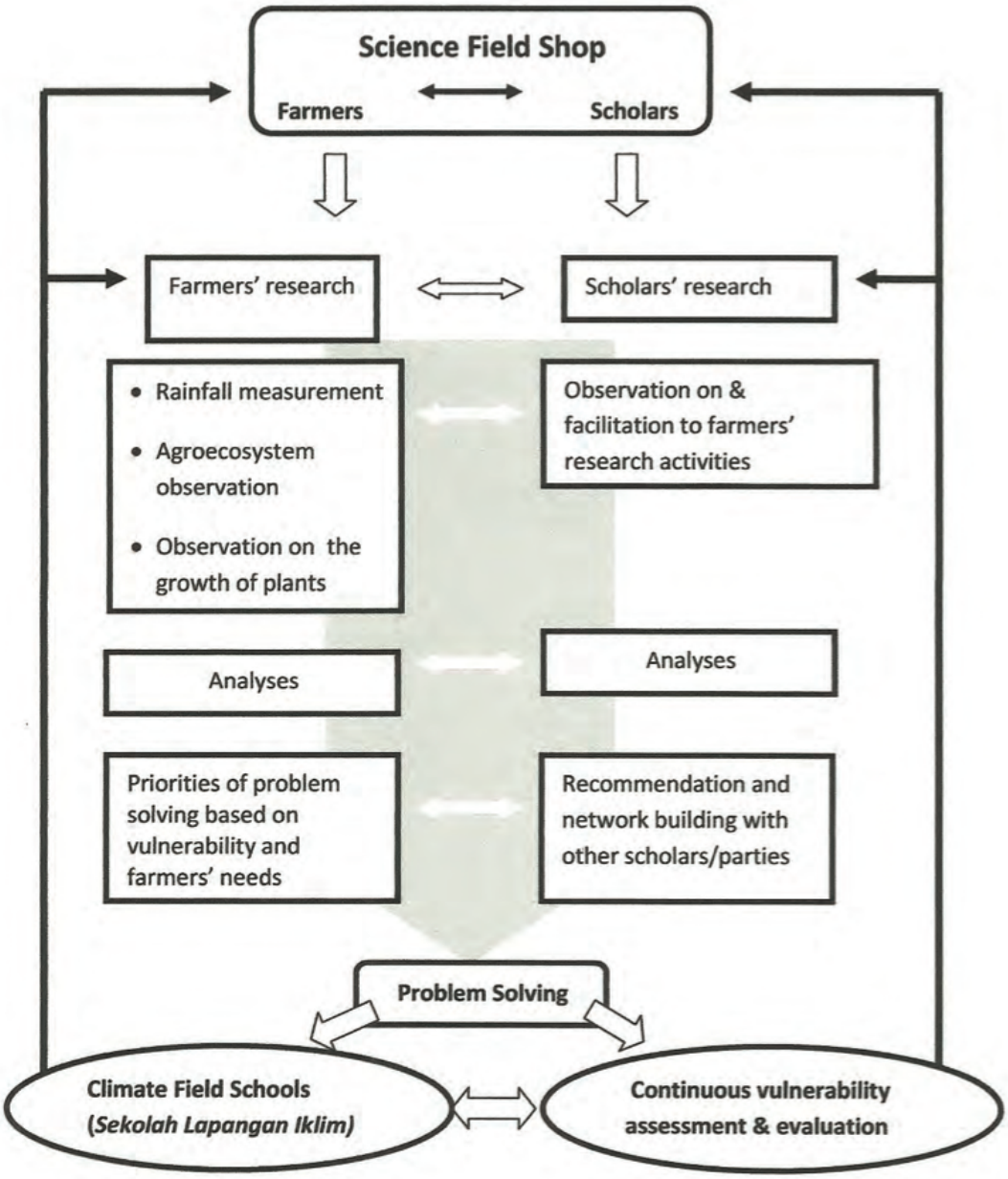
Chapter 2. Science Field Shops, Indramayu, Sampling and Methodology

With the conceptualisation of new approaches and implementation of new approaches, the seemingly unavoidable side affect is the coining of new terminology, and with it, new abbreviations. This chapter will give an introduction into what is meant by Science Field Shops (SFSs) and then moves on to describing how the SFS concept has been implemented in Indramayu. This description will delineate some important background information that builds up to the data described further in the thesis, such as what the roles are of the scientists and the farmers and how these have materialised in Indramayu. Within this chapter there is also a small section with some general background information about where Indramayu lies within Indonesia and the local, cultural context in which the farmers live in, and more than often grown up in. It is added to give some flavour behind the word 'Indramayu' and with the background information on the dynamics of the collaboration between the scientists and farmers in the SFS in Indramayu, it gives a basis for the data chapters (starting in Chapter 4). After the section on Indramayu this chapter moves on to describe the sampling and methodology used while collecting data in the field. Within the description the choices made in the sampling and methodology will be explained and justified, and are based on the description of the SFS in Indramayu given below.

The Science Field Shop in Indramayu

The Science Field Shops (SFSs) is a name coined by Kees (C.) Stigter and Yunita Winarto in their book 'Agrometeorological Learning: Coping Better with Climate Change' (2011), and refers to a participatory learning approach that is based on the 'Law Shops' in the Netherlands, but also bares similarities to the Farmer Field Schools (FFS). Diagram 1 shows the conceptualisation of the Science Field Shops, and has been developed based on the case study in Wareng, Gunungkidul. In Wareng the approach continued the training that was first instigated by the Climate Field Schools (CFSs), and worked with a group of farmers that had all participated in the CFS (Winarto et al. 2008; Winarto et al., 2010; Winarto and Stigter, 2011). In their work in Indramayu, only one member has participated in a CFS prior to participating in the SFS approach. The history that leads to the current collaboration between the farmers and scientists in Indramayu is complex, and during my time in the field and as part of the team of scientists, I was only able to get an impression of the historical dynamics that led to the formation of the 'Klub Pengukur Curah Hujan' (which translates into English as the Rainfall Observers Club, from here on out to be referred to as KPCH). In a book that is still being written, a more comprehensive discussion of the dynamics at the start of the collaboration with the farmers in Indramayu will be given, and here I will limit myself to sketching a picture of the current collaboration between the farmers.

Describing the collaboration between the scientists and farmers without doing it an injustice has been rather difficult. My previous attempts have portrayed the collaboration as something 'top-down', while others have idealised it as a great example of a 'bottom-up' approach. Neither captured what it really is, which is a balance between top-down and bottom-up, best described by the word *collaboration*. The farmers are all members of KPCH, and to differentiate the members of the club with non-member farmers, the farmers who are members will be referred to as (club) members, while non-members will be referred to as farmers. The club members main activities within the club is the collection of rainfall data using an 'omplong' (rain gauge) and making observations related to the agrometeorological conditions in their fields, as well as writing down their own farming practices. The rainfall data is measured daily, between 06:00 and 07:00 in the morning, while the observations are written down for a ten day period (referred to locally as a



Source: Winarto *et al.* 2010c, 2011. Reprinted from Winarto *et al.*, 2011:179.

Diagram 1. The Science Field Shop approach, reprinted and adapted from Winarto and Stigter 2011:222.

'dasarian'). These activities are the club members research, and the findings are discussed during the monthly meetings, which normally take place on the first Sunday of the month. The meetings start with one member from each village sharing their rainfall data and observations with the group. From this data the interesting observations are taken for further discussions, which could include specific pest outbreaks, diseases, flooding events, the impacts of drought, among others. At these meetings the scientists are also present, and they also participate in the further discussions, and are at times asked by the club members on their take on a certain problem. In Diagram 1 it states that the scientists are facilitating the farmers, in this case club members, research as well as making observations on these activities. In this sense they are both conducting their own research on the activities in the club, as well as problem solving in the sense of helping the members conduct their research and identify problems and solutions on their farm.

Picture 1. Pak Amin measuring the cracks in the soil near the end of the dry season. The cracks were around 50cm deep. *Photo: Muki Wicaksono.*

Picture 2. Pak Dadi showing us how he measures the rainfall. It looks to be around 10mm. *Photo: Onno Giller.*

Picture 3. Pak Condra's omplong in his paddy fields. He has painted it red in order to avoid metal scavengers stealing it. *Photo: Onno Giller.*

Picture 4. An unidentified farmer converting the data in his book into a monthly graph. *Photo: Ubaidillah Pratama.*

Striking a balance between science and facilitation

In the current set up in Indramayu, the scientists participating are a team from within the Department of Anthropology at Universitas Indonesia (UI) led by Yunita T. Winarto and an agrometeorologist, C. J. (Kees) Stigter, Founding President of the International Society for Agricultural Meteorology (INSAM, 2013) and Agromet Vision. The team of anthropologists act as cultural, and indeed language, translators between the club members and Kees Stigter, while Kees Stigter is the source of expertise on the main focus of the collaboration: the changing climate and its impact on the farming practices. Kees Stigter visits the field sites in Indramayu at least once a year, and prior to these visits the farmers are given a chance to write down any questions they may have related to their research or farming practices. During these visits Kees Stigter discusses the findings of the farmers' research with them and gives advice on problems both related to carrying out the research as well as problems in the members fields. Another part of Kees Stigters involvement in the collaboration is that he sends a brief update each month on the climate change forecast for the coming season, which is translated by Yunita T. Winarto and her team, before it is sent on to the farmers via text message. This also highlights the fact that Kees Stigter is not only involved in the project during his visits to Indramayu, but is also in contact with the team at UI during the rest of the year, and problems and questions that arise during the year are discussed with him over e-mail and/or skype. Although it is clear that Kees Stigters importance in the SFS that is developing in Indramayu is significant, as he has an important role as the expert with regards to all things agrometeorological, this does not take away the importance of the team of anthropologists based at UI, with whom I worked with during the carrying out of the research for this thesis, and with whom I was working with as an intern.

The team of anthropologists at UI consists mainly of Yunita T. Winarto and her students, varying from Bachelor to PhD, who are interested in doing their thesis by researching this collaboration and/or want to have experience working on a collaborative project. The research topics vary, and are not necessarily confined to the collaboration between the scientists and farmers. This is made clear by the class of students who will be going to Indramayu for the field trip as part of their methodology course and will be doing research into a wide range of topics such as migrant workers, health, environmental contamination, etc. The actors involved in this team both carry out their research as well as participate in the clubs activities. The activities that the scientific team carry out vary, and these can be divided into three categories. The first category is the facilitation of the members' research, through collection of their rainfall and observation data and converting it into excel for ease of analysis by the scientists, visiting the farmer to see how their research is going, checking if they are encountering any problems as well as checking if their rain gauge fits the required specifications. The second set of activities expands the learning process, as the scientists facilitate workshops for the farmers as well as getting in contact with other scientists from various disciplines to help answer questions farmers have. The last category relates to the administrative aspects within the collaboration, such as helping the farmers with their budget and sourcing funds to increase the budget. Within all three categories the scientist aim to fit their activities as best as possible with the ideas the farmers have, not forgetting to voice their own opinion, as most of these activities have the farmers priorities in mind.

Klub Pengukur Curah Hujan (KPCH)

The reason given for the club members to organise themselves as a 'club' rather than a 'farmers group', was the freedom it gave them to invite members from all over Indramayu, as the farmers groups are area specific and follow a hierarchy with different levels going from village

level till national level and have to be registered with the government. The club has the freedom to invite any farmer they like into the club, with their own requirements for admission. These requirements are simple: the new member should be serious about doing the research and wanting to learn. The club members vary in age, experience in farming and level of education. This difference in experience can influence the learning process, as some farmers are 'catching up' while the more experienced farmers may not think it is going fast enough. The other side to this 'gap' in knowledge is that the more experienced farmers can share their knowledge with the less experienced. The content of the workshops were (or indeed, are) determined by the members, and in one case the workshop on plant breeding was entirely organised and facilitated by the members themselves. The scientists were mere (participant) observants. This is an example of a formal arena of where the members exchange knowledge, which also takes place during the meetings and in interactions outside of the meetings. The making of a club is more informal, but still requires leadership to keep the club running. During the first meeting when the club was set up, the members decided who they wanted for positions of leadership in the group, and Pak Amin became the Leader, Pak Abas became the Secretary and Pak Kuwu Sunaryo became the Treasurer. All the other farmers became members in the club.

Being a member of the club means participation in the clubs' activities. The central activity in the club is the collection of rainfall data and doing observations in their fields on a daily basis. Each members is supplied with an 'omplong' (a local Indramayan word loosely translated as 'container', and is their simple version of a rain gauge) currently being made by Pak Dadi, a member in Nunuk. It is a simple metal cylinder, of which the top is open and is 10 centimetres in diameter in accordance with Kees Stigter's specifications. This cylinder is then placed on top of a pole, 1.5 metres high, and at least 10 metres away from any obstruction (such as houses, trees and other larger objects) within the field that the observations are being done. This can be both in the member's own field, but also in a field of another farmer if they do not own fields or if they feel their fields are too far away from their house. A simple wooden stick is put into the cylinder, and the water makes a mark on the stick which is measured with a ruler, and then the resulting data is noted in the member's data book. The club members and Kees Stigter have agreed on doing their measurements between 6 and 7 o'clock in the morning, to keep the data uniform and make sure that circa 24 hours has passed since the last measurement. The observations they carry out alongside the rainfall measurements, contain two subcategories. The first subcategory is the observations on the farmers own activities, such as which pesticide they used and when, the fertilizer applied, the variety used, water management, among others. The second subcategory is the observations on the condition the fields are in, such as whether the crop is in good condition, if pests and diseases are present, what does the soil look like and is there enough water. These observations are summarised in the data sheets for each 10 day period (*dasarian*), thus they have three data sets of observations for each month. The monthly meeting held at different members houses each month, is important for the farmers to be able to discuss the research that they have undertaken over the past month. Actively participating in the research and meetings is the main requirement of being a member in the KPCH.

Indramayu

Nearly all of the members have grown up in Indramayu, which is a kabupaten (regency) that lies on the North Coast of Java, within the provinsi (province) of Jawa Barat (West Java). The island of Java within the Indonesian archipelago does not only constitute of the Javanese ethnic group, although these do make up the majority of the population of Java (Encyclopedia Britannica, 2013). One of the other ethnic groups on Java are the Sundanese, and Indramayu, lying on the North Coast

of West Java close to the border with Central Java, can not be classified as 'Sundanese' or 'Javanese'. Kurasawa (2007) states that "they are essentially javanese in their basic character, though transformed by Sundanese influences" (Kurasawa, 2007:53). An extension officer explained to us that you can tell if somebody is Sundanese or Javanese by the way they eat their sayur asem (a type of vegetable soup). A Sundanese will drink the liquid form the bowl, leaving the vegetables, while a Javanese will spoon the vegetables onto his plate and eat it with rice. An interesting anecdote that shows that their heritage is something they do think about, although this distinction did not really pan out as most people seemed to eat their soup in the way they felt like it. Such experiences in the field have shown that there is still a distinction made Sundanese and Javanese traits, yet in essence they perceive themselves as 'Wong Indramayu' (A person from Indramayu).

The history of Indramayu provides insights into Indramayan culture. Kurasawa (2007) gives a good synopsis of past rulers that give an indication into how the current culture has slowly but surely formed over decades. Originally the area was part of a Hindu kingdom, Pajajaran, before they lost control and Indramayu became part of the Banten Kingdom, whose major religion was the Islam. During this time immigrants from the other provinces of Java came to Indramayu and "according to legend, were the first rice cultivators of Indramayu" (Government of Indramayu Regency, 1960, found in Kurasawa,2007:53). Rice is the staple food crop in Indramayu and makes up a large part of the diet, and the Indramayan farmer's expertise lies firmly in the growing of rice (Siregar, 2010; Siregar and Crane, 2011). Within Indramayu and across Indonesia, it is considered that if you have not eaten rice, you have not had a proper meal. The local language has its roots in the Javanese language but is a dialect that has shaped over time in which distinctively different words and phrases have arisen. '*Bisa dewek*' (We can do it ourselves) and '*omplong*' (container) I was told were good examples of local words, that belong to Bahasa Indramayu. One of the significant observations made in the field was that the farmers in Indramayu seemed to be very direct and open, while most Javanese from other regions are very polite and less likely to openly challenge somebody. The directness of these farmers hopefully also gives more credibility to the data collected.

Sampling

On entering the field, the club membership counted just over 50 active members, and during an evaluation to see how many active members there were this shrunk to around 40 active members, with some members leaving due to a myriad of reasons (personal health, other more pressing activities inhibiting them from carrying out their research or even changing profession). The map below (Diagram 2) is an old overview of the club members, yet does show how widespread they were within Indramayu. Each member has his own code of where his research station is (aka where his rain gauge is placed) and these indicate a distinction between the North-west (NW), South-west (SW), North-east (NE) and South-east (SE) of Indramayu and which member was part of which zone. Since travel times and distances between the villages and members could be large, interviewing all of the members was infeasible. Taking the 4 different zones, 5 members were chosen for each zone, giving a total of 20 club members to be interviewed in depth. In three of the zones, NW, SW and SE, a large proportion of these 5 farmers where chosen from the same village. This was done to understand the dynamics between members from both a village and regency perspective. It was also done due to ease of transportation to the members houses and paddy fields. In the NE, the members were more isolated and the travelling distance between members was larger. These more isolated members were chosen as an interesting comparison to the farmers who lived in a village with multiple members and possibly more interaction possibilities with other members. Another process in the selection was that of these 20 members selected, 3 of them would

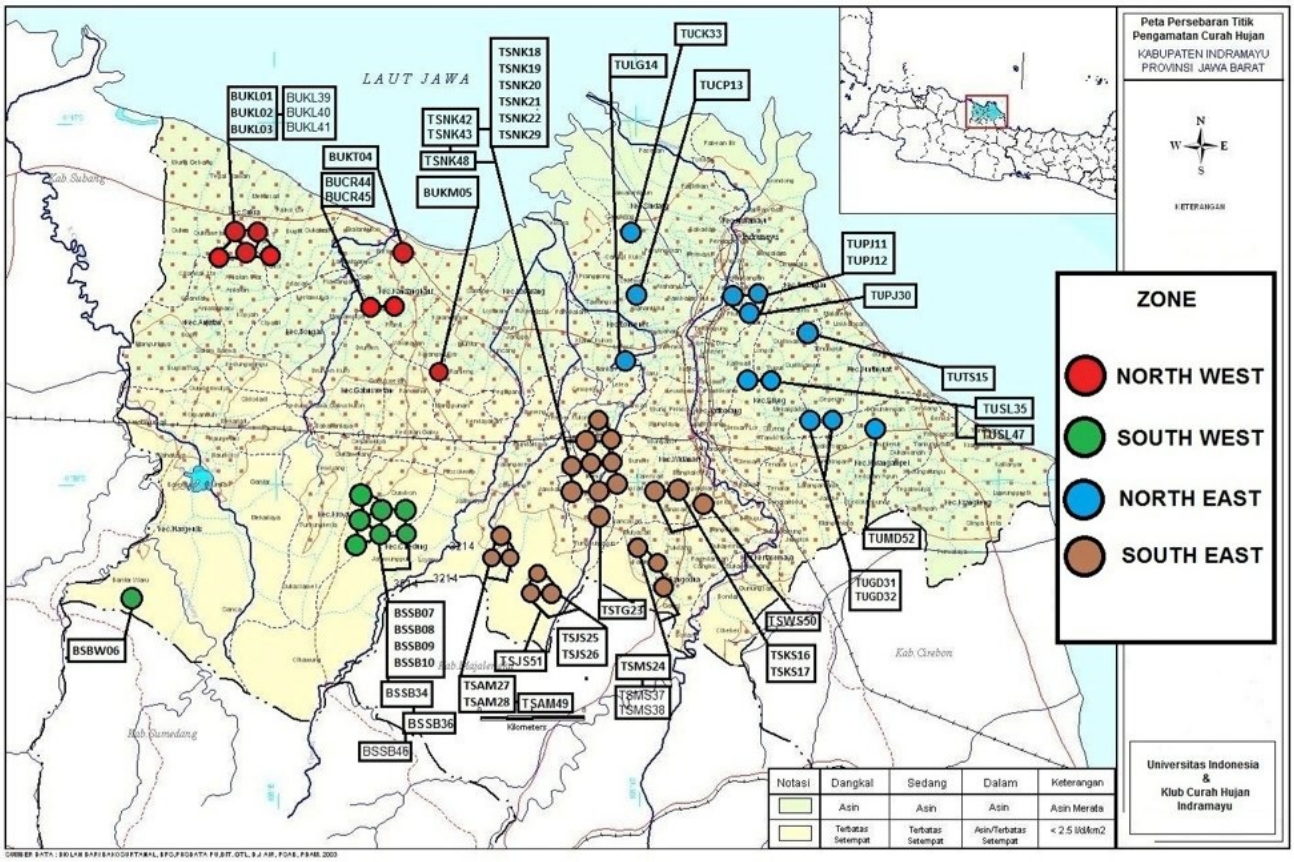


Diagram 2. Map of the Regency of Indramayu, with the specific locations of the farmers participating in the Science Field Shops (Made by UI and KPCH).

Agro-ecosystem	Definition
Irrigation	Main access to water is from the irrigation canals
Half-irrigation	Only access to water from the irrigation canal if there is rain (which can also fall in other areas that supply the canals)
Dry-rainfed	Only access to water from rainfall

Table 1. Definition of the agro-ecosystems defined by the Klub Pengukur Curah Hujan.

be the leaders of the club to be able to get their impression of the club as they are important figures in keeping the club running. Out of the 20 members chosen for in-depth interviews, only 16 of these were able to be carried out to their full extent, another 2 were only 50% complete, another 1 is missing a few questions and 1 was missed out on altogether. This was due to being ill in my last field trip to Indramayu, in which I wanted to do the final interviews androgens do a catch-up interview with two others.

Another reason for choosing these 4 zones was the difference in agro-ecological categorisation done by the club. A large majority in the SW zone were categorised as dry rainfed or half-irrigation. In the SE zone they categorised themselves between irrigation and half-irrigation. In the NW the members were farming with a relatively good source of water supply from the irrigation system, while in the NE zone it was dryer and the members mainly depend on rain as a water

source. To understand their own categorisation, the categories in Table 1 were drawn up from the data given in in-depth and casual interviews. Another variable that was used to select the members was their status in the club. This confined itself to at least interviewing the leader, the secretary and the treasurer of the club. The other informants were counted as members, and in selection for interviews their possible status within the club was not taken into consideration.

While in the field in Indramayu, various officers belonging to different departments were also interviewed. These included agricultural extension officers and irrigation officers. Other farmers were also interviewed in a more casual manner, met while visiting members houses or paddy fields. These interviews were carried out to get a broader impression on what it means to be a farmer in Indramayu, as well as get other inputs into the institutions that could constrain or be beneficial to farming in the area. There were also three in-depth interviews carried out with farmers who had participated in the government run Climate Field Schools, to get an impression of how other farmers had experienced climate change learning and whether or not they still continued this learning process or not, and if they were interested in doing more in the future.

The scientists interviewed were all of the scientists currently working within the collaboration, and a few of the students that had previously participated were also interviewed. Going back to students who had already left the collaboration was done to broaden the data from the scientific side of the collaboration as well as to get impressions on how the collaboration was in the past and what they hoped to see happening at the moment and in the future. For them it was more reflexive than current, and this could give interesting insights compared to those who were heavily entrenched in the work at the time of the interview.

Methodology

The methodology was a combination of semi-structured, in-depth interviews, casual interviews during observations, as well as participant observation by being part of the collaboration. The semi-structured, in-depth interviews contained a pre-set list of questions that were asked in a more or less random order to fit the flow of the interview. The same questions were asked to each member in order to get a solid data set for comparison, while the more casual interviews with both members and other farmers were gathered for extra information and possible comparison to the main data set. The participant observation refers to my position as both doing my research as well as being part of the team of scientists, who participate in the monthly meetings and other events such as workshops and executive meetings run by the club leaders. By being able to participate in all these activities, an advantage was gained in getting insight into the inner workings of the collaboration. Being part of something and then being able to stand back and analyse what has happened, is another challenge altogether.

Another challenge was working with a translator, as it was impossible to master the language comprehensibly enough in the time frame to be able to carry out the interviews personally, especially since the local language and dialect were sometimes also challenging for the translator. The translator, Muki T. Wicaksono, was a bachelor student who was also doing his thesis on the project. Having worked within the collaboration prior to my arrival, his knowledge on the collaboration as well as the field sites proved useful in gaining contact with the informants. His level of education in a comparable field of study made it easier to clarify the questions as well as ask them to the informants. His knowledge of the objectives of my research and the possibility of him guiding the answers are there, yet I trust him to have been professional as a fellow researcher, especially due to the questions he asked me to clarify any questions I asked in the field that he did not understand.

An alternative source of data were the publications, theses and various documents within the collaboration that may have bearing to the objectives of this thesis. The various documents pertains mainly to the data collected by the farmers and the translation of this data into graphs and tables in excel. The scope of the documents accessible was limited due to a language barrier, and some bachelor theses are not accessible due to being written in Bahasa Indonesia, although the abstract is written in English so an indication of the contents is possible. The publications by the scientists gave good insights into the framing of the project as it gave indications of how the scientists perceived the work that was going on, as well as how they want to portray it to the outside world.

Technography and theory

This chapter has given various pertinent background information that will be useful when reading the data chapters starting in Chapter 4, and then outlined the methodology used to obtain the data that is discussed. This more practical account of the methodology and sampling used, bases itself in technography, which is the theoretical framework that was used to narrow down the broad scope of ethnography. The following chapter outlines the theory used within this thesis to analyse and discuss the data, as well as justifying why these theories are relevant for this thesis. This thesis then also goes further into depth about what is meant with ‘Technography’.

Chapter 3. Technography, Practice Theory and Framing

Before this thesis starts describing and analysing any data, the theories that underpin the analysis of this data will be explored and how these have had a bearing on the conceptualisation of the research presented. The main theory that this chapter will discuss is practice theory, and while doing so the main principles of practice theory will be outlined, and the implications it has on this thesis will briefly be discussed. The notions of framing will also be outlined to sketch why the framing of the SFSs is important, and to clarify the definition of framing that is used within this thesis. Framing will also be shown to be complementary to practice theory, as practice theory principles are useful in understanding interactions between various actors and how their respective practices are embedded in their social and technological context. Yet it does not provide a good way of analysing how these various actors perceive their own practices as well as those of others, and in turn, how these influence the practices themselves. The first thing to be discussed in this chapter is technography, a methodological framework that was integral in conceptualising the proposal that preceded this research, and within which the notions of causal mechanisms and epistemological stance this research makes are grounded. As part of this methodological framework the Actor Network Theory (ANT) provided useful in the collection of data while in the field, yet this chapter argues that practice theory is a better way of analysing the social organisation of the Science Field Shops (SFSs) within this thesis at it provides continuity and is also a better fit with the data collected.

Technography and mechanisms

The simplest definition of technography is that it is a "ethnography of technology" (Jansen and Vellema, 2011:169). Jansen and Vellema (2011) go on to describe that the "principal aim is to facilitate research into the shaping, use and impact of technologies in concrete social situations" (Jansen and Vellema, 2011:169). This facilitation of research means that it is not necessarily a theory, but more of a methodology that takes insights from various relevant theories in order for the research to be focussed on the research question being proposed. It invariably combines various lenses through which the research topic can be analysed. Within technography, the technology can take many shapes and are not merely artefacts such as a plough or irrigation system. This thesis recognises the Science Field Shops (SFSs) as a form of social technology, an artificially created space in with scientists and farmers can organise themselves while participating in the co-production of knowledge. This artificially created space aims at being a tool through which vulnerabilities are identified and adaptation strategies are created to help deal with these vulnerabilities. A concrete example of a process of making is agriculture, where agriculture is the process of making agricultural goods (e.g. rice). Taking the network as an artificially created space with the aim of improving agricultural practices, it is in itself a process of making, as it concerns itself with generating knowledge to aid both the farmers agricultural practices, but also aiding the scientists practices in doing more applied research. An overview of the levels of processes of making this thesis addresses, is given in Diagram 3. This thesis thus focusses on how the process of generating knowledge within the SFS network influences the processes of scientific practices and the processes of agricultural practices.

As technography is a methodology that can incorporate different social and natural science theories, Jansen and Vellema (2011) state that it "may conflict with some contemporary social science approaches as well as common sense beliefs about the social" (Jansen and Vellema, 2011:176). One of the reason conflicts may occur is the epistemology that is connected with technography, and the notion of causality it embraces. The epistemology closely connected with

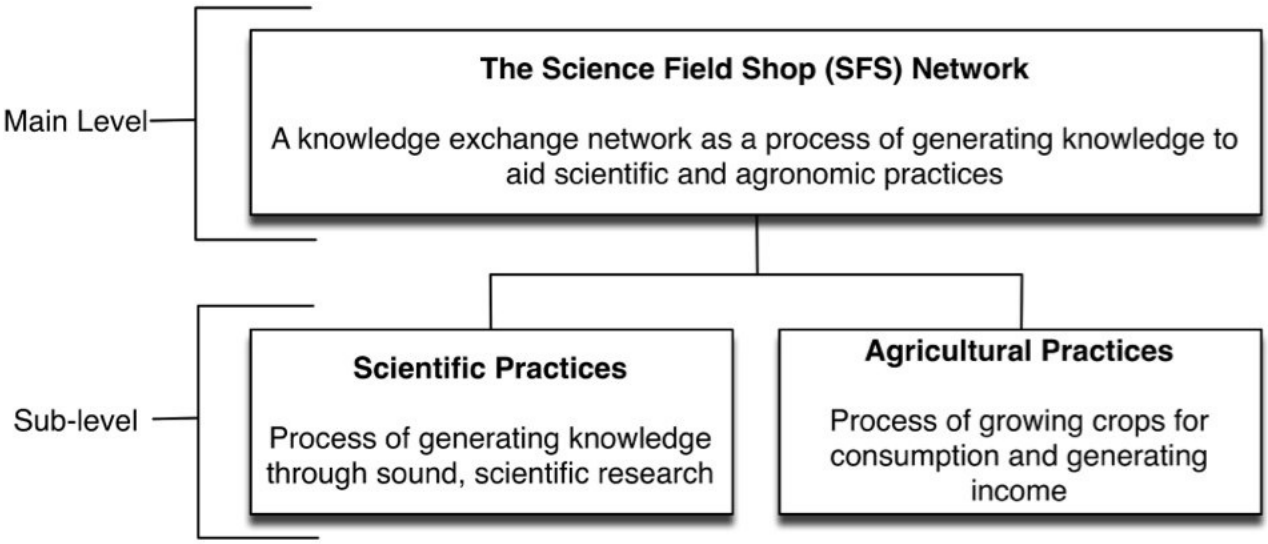


Diagram 3. The different levels of 'processes of making' this research contains.

technography is critical realism. Within critical realism, the social and natural processes are taken as separate, which is something that practice theory critiques in it's "*rejection of dualisms*" (Feldman and Orlikowski, 2011:1242, highlighted as in original). Yet this separation is useful as it allows the investigation of how the natural, biophysical processes influence the social and vice versa. It is a way of unpacking complex practices and analysing them, and then seeing how these different processes are embedded within the practices, which is in line with practices theory.

Within critical realism the 'real', both social and natural, exists with its structures and powers, regardless of our knowledge about it. Sayer (2000) stratifies this between the actual and the empirical. The actual is when within the 'real' the powers are activated and the effects occur. The empirical is our experience of the actual and our attempt at defining what it is. In critical realism there is thus a notion of causality that differs from more extreme forms of realism. Here there is an inclination to talk about mechanisms (Sayer, 2000). Mechanisms are 'the pathway or process by which an effect is produced' (Gerring, 2007:161). Mechanisms may be essential for an outcome, yet contextual differences in outcome occur with both spatial and temporal variation (Sayer, 2000). In this sense mechanisms can give an indication of what is important within a certain process, yet cannot give a conclusive answer on the actual outcome. This means that other social science theories that work within the epistemelogical stance of constructivisim, as well as theories that work from a different principle of causality, may not fit as well within the framework of technography.

The mechanisms that this research is looking for vary, depending on which aspect of the research is being analysed. During the discussion of adaptation as a concept, and related concepts such as adaptive capacity, that adaptations to practices would be seen as processes. This adaptation itself could be seen as a mechanism in negating climate change impacts. An example would be that a farmer has changed his crop types from rice to vegetables to be able to cope with drought. The adaptation is thus the 'mechanism' in coping with drought which is the 'effect that is being produced', while the mechanism can take on may forms, e.g. planting of rice varieties that can better cope with drought. A mechanism does not necessarily have to be singular, and can be part of a longer chain of mechanisms, as the mechanism that precedes adaptation is understanding what has caused the farmer to be able to implement the decision. These mechanisms would have to be deemed to be 'key' to production of the effect, but the shape the effect takes (level of coping with drought, type of adaptation) is not stable. These examples tie into the research question on adaptations, but other mechanisms will be looked for when analysing the data to answer the remaining questions. When looking at the function of the network in influencing practices, the

changes in practices as a result of participation in the co-production of knowledge, and the parts of the co-production of knowledge that have made these changes possible, would be the possible mechanisms. The list of possible mechanisms extrapolates, the deeper you go into answering the questions, and identifying the 'key' mechanisms is important. Access to sufficient water may be a mechanism that could help increase crop survivability, yet access to labour at the correct time to ensure planting early may have a larger impact on the ability of a crop to survive. In this way, the mechanisms can also be ranked in order of importance. Mechanisms are thus more flexible in their attribution of causality, and rather than falling into the trap of attributing significance to each mechanism, finding those of more importance may bare more significance in understanding the dynamics as well as towards scaling up the approach to other areas in Indonesia.

Practice theory

Practice theory is not the easiest of theories to grasp, and in reading the book by Schatzki (2001) there is sense that it is a very comprehensive overview of, and discussion of practice theory, but not an easy introduction to the theory. Another paper by Feldman and Orlikowski (2011) gives an overview of practice theory that is easier to digest, and also gives a good overview on the different views on practice theory by an array of sociologists, including Bourdieu and Giddens. The three principles of practice theory noted by Feldman and Orlikowski (2011) are (1) "*everyday actions are consequential* in producing the structural contours of social life" (Feldman and Orlikowski, 2011:1241, highlighted as in orginial), (2) "the *rejection of dualisms* and recognition of the inherent relationship between elements that have often been treated dichotomously" (Feldman and Orlikowski, 2011:1242, highlighted as in original) and (3) "the *relationality of mutual constitution*" (Feldman and Orlikowski, 2011:1242, highlighted as in original). Of these three principles, the first is the easiest to relate to Richards 'agriculture as performance'. Within 'agriculture as performance' the key is that farmers do not necessarily take decisions at the beginning of the season, rather they continue to re-evaluate their farming practices throughout the season. In this sense, the normal, 'everyday actions' of the farmers are instrumental in defining both the social and natural aspects of farming practices. The second principle refers to the theorisation that, in the example of agriculture, farmers are not set apart from their farming practices, yet that they embody them, rather than that their knowledge of farming is set apart from their on-field practices. As knowledge plays such an important role within the SFSs, and in turn to some extent this thesis, it is important to understand the definition of knowledge along the lines of practice theory, and it has been defined by Orlikowski (2002) as "an ongoing social accomplishment, constituted and reconstituted in everyday practice" (Orlikowski, 2002:252, found in Feldman and Orlikowski, 2011:1243). The third principal of practice theory, theorises that all social order is entrenched within the agencies that enabled it's existence, while this agency is in turn enabled by already existing structures. The *mutual constitution* and the *relationality* is that the agency and the structure can not exist without the other's presence, yet this connection does not mean that they are on equal footing as power relations also play a role (Feldman and Orlikowski, 2002). This then hints back towards the "fields of practices", which Schatzki (2001) defines as "the total nexus of interconnected human practices" (Schatzki, 2001:11).

The three principles of Practice Theory

The three principles of practice theory are discussed on an abstract level, and to be able to use practice theory as a useful way of analysing the data, there is a need to apply the abstract notions to more concrete examples. The addition of the research (collection of rainfall data and

observations) to the farmer's practices could be a good example of the first principle, "*everyday actions are consequential* in producing the structural contours of social life" (Feldman and Orlikowski, 2011:1241, highlighted as in original), as these new 'everyday actions' have expanded the 'structural contours' of their social lives, as they discuss and exchange their findings with other farmers and scientists. The act of getting up in the early morning to go and measure the rainfall has seemingly changed their normal routine, and in turn also their social life with respect to their family activities and wider social network. The scientists in the project have also changed the 'social contours' of their social life by joining the collaboration, by both expanding their network and changing their 'everyday actions' to include administrative activities and contacting the farmers about their research. For both the farmers and scientists this change in daily actions has changed the structural contours of their lives, yet these are relatively drastic changes. A more normal every day action, such as going out to the fields to check on the crops, shape the contours by defining who you meet and interact with while performing these activities.

In line with "the *rejection of dualisms*" (Feldman and Orlikowski, 2011:1242, highlighted as in original) the local climate and weather both share an inherent relationship with the farmers in their ability to practice agriculture. There can be an implicit understanding of weather occurrences by farmers, and the ability to know what to do in the event of a drought (as an example) reflects the competency of the farmers agricultural practices. The dichotomisation of what are 'farming practices' and what are not, is another type of dualism practice theory rejects. A death in the family, migrating to find work overseas, festivals and religion are examples of aspects of daily life that one may not necessarily link with the farming practices, but are through the lens of practice theory, very much an integral part of farming practices. Depending on the culture, a death in the family may disrupt on-farm activities for a matter of days or weeks as this is how long the mourning and funeral process may take place. On a more positive note, this may be the same for an important festival. These various activities may not have 'direct' connection to agriculture, but can have impacts on the way farming practices are organised and carried out. The second principle is also useful when analysing the network with in the SFS, as it rejects the notion that the network is limited to only the actors who are actively participating in the SFS, but expands it to both actors outside of the SFS and actants. The wider network in which the agricultural, scientific, and indeed, learning practices are embedded, are important in understanding the dynamics of these practices, as well as how it interacts with adaptation processes.

The final principle of practice theory, "the *relationality of mutual constitution*" (Feldman and Orlikowski, 2011:1242, highlighted as in original), bares similarities with the second principle, and goes further than just a 'relationship' as it means that one cannot have the same existence, without the existence of the other. In this sense a deep bonded relationship. The structure of network within the farmers club would not be in existence without the farmers, while the farmers would not have the same agency if it did not have the network. Thus they can 'exist' without the other, but not in the same way. This notion of interconnectedness of agency and structure within practice theory could provide interesting insights when used to analyse social organisation. Taking this into consideration it may be so that the introduction of the SFS in Indramayu has given a platform for the social organisation to take place, yet the practices promoted do not necessarily define the structure of the social organisation as this is also related to the varying degree of agency of the actors involved. Another way of looking it is the fact that the farmers research practices would not be carried out the way they are now without the presence of the scientists, as they were both instrumental in their conception, as well as their prolonged occurrence. The farmers on the other hand are shaping the scientists practices in this regard, as the scientists are changing their approach based on the farmers troubles or innovations. The organisation of the monthly meetings is both being shaped by the various actors (scientists and farmers) but also shaping their practices by

needing to take the time out to go to the monthly meeting. There is thus a necessity of both the scientists and farmers to participate in order to shape the network of the SFS, shape their relative practices as well as shape the relative agency of the actors. These various examples are what the third principle can help shed some light on, while also helping identify which interlinking relationships are instrumental in propagating the SFS in Indramayu.

The practices discussed above fit into the dimension of 'making', one of the three dimensions within technography outlined in Jansen and Vellema's (2011) paper discussing technography, and the other two dimensions are distributed cognition and construction of rules. In line with these dimensions, this thesis focusses on the dimension of making, where the SFSs are creating a space where scholars and farmers can organise themselves while participating in the co-production of knowledge. This co-production of knowledge is in turn also concerns itself with dimension of making, as it is about the creation of knowledge that is aimed at improving the knowledge generated by science and the improvement of the growing of crops through agriculture. The three principles outlined above will be used as the cornerstones of the analytical lens through which the 'processes of 'making'' will be analysed. These processes of making are the agricultural practices, the scientific practices and the co-production of knowledge within the SFS in Indramayu. Practice theory also provides an interesting analytical lens through which the network that the collaboration is creating in Indramayu. This implementation of technography thus uses the principles of practice theory as the framework through which the processes of making will be analysed, but reaches out to framing in order to analyse and understand the implications of the perceptions within the SFS approach, and how it is presented to the wider, international community.

Framing

The questions that still remain are those of why the different actors are participating in the SFS? How do they think they will benefit? What are the problems they are working on? Do they agree as to what the focus of the SFS should be on? This is where framing comes in, as it adds an extra facet to practice theory by analysing the perceptions on the practices the various actors are involved in. Sumberg et al. (2012) discuss the impacts of framing on agronomic projects and research, referring to framing as "the particular contextual assumptions, methods, forms of interpretation and values that different groups bring to a problem, shaping how it is bounded and understood" (Sumberg et al., 2012:11). While conceptualising an approach there is an inherent assumption as to which problem is being tackled, and what these problems mean for the target group. Assumptions and perceptions on the problem may clash with other actors who are affected by the implementation of the approach. In this sense the impacts of climate change may mean different things for farmers, as their understanding of what climate change is may differ to that of the researchers. Understanding how the different actors are framing a problem will give indications on the complexities the approach has to deal with, as well as the outcome of the approach is for the groups involved. In a long-term approach such as the SFS in Indramayu, framing is just as important, as the different groups are working together over a prolonged period of time, and understanding how they perceive the collaboration and the respective roles within it, and how they portray the work they are doing to the wider community, can gain insights into the dynamics of the collaboration. To operationalise the notion of framing as a mode of analysis, the notion of framing according to Sumberg (2012) will be used. The SFS in Indramayu will be analysed through 'the particular contextual assumptions', the 'methods', the 'forms of interpretation' and the 'values' the various actors attribute to the collaborative research they are participating in.

Moving away from the more actor orientated 'framing' of the SFS approach, it will also be looked at from a policy perspective, which will provide useful when understanding how the SFS is

portrayed to the wider (international) community. Dewulf (2013) analysed the different ways of framing climate change adaptation within policy, and outlined them "as a tame technical problem versus a wicked governance problem" (Dewulf, 2013:324) and "as an issue of state security versus human security" (Dewulf, 2013:325). The 'tame technical problem' refers to the problem of adaptation as an implementation of technology, through creating new technology or making existing technology available. The 'wicked governance problem' on the other hand refers the problem of adaptation as a political and social relations issue where issues such as bureaucracy need to be changed in order for actors to cope with climate change. The securitisation of adaptation as a concept is done according to Dewulf (2013) on two levels, the systems level which is coined as 'state security' and actor orientated level which is coined as 'human security'. The "securitisation", as it were, of climate change adaptation policies, is defined by Dewulf (2013) as "framing an issue as a matter of security in order to increase its priority on the political agenda, to silence critical voices or to legitimize drastic measures" (Dewulf, 2013:325). The different levels of security framing, 'state security' and 'human security', have different implications for the focus of the policy. The 'state security' looks at policy that has implications for the state as a whole, while 'human security' looks more at the implications for individuals or smaller communities, and does not necessarily differentiate between which state they are residing in (Dewulf, 2013). The SFSs are in a way a policy initiated by the scientists Yunita Winarto and Kees Stigter, and are part of a broader policy that aims to create a network throughout Indonesia (Stigter and Winarto, 2013). By taking the classifications by Dewulf (2013) an image can be sketched on the framing of the policy as a whole, and be compared with the framing of the actors involved in Indramayu. Rather than try to 'fit' the SFS approach in one of the classifications, the analysis will look at the the similarities with the classifications. This is done because the SFS approach does not necessarily frame the problem of climate change adaptation through one particular frame specified above, but it can be a more complex frame that incorporates more than just one of these frames. This thesis thus looks at framing from the participating actors perspective, as well as analysing it through a policy lens to see how the SFS approach is framing the problem of climate change adaptation.

Technography, practice theory and framing

The interconnectedness of technology and society that is key to technography links closely with the third principle of practice theory delineated in Feldman and Orlikowski (2011), namely "the *relationality of mutual constitution*" (Feldman and Orlikowski, 2011:1242, highlighted as in original), where the mutual constitution relates in this case to technology's role in changing society, yet the society is what has created the technology and has helped shaped it into its' current form. In essence, there would be no technology without society, yet the structure of society is also in part determined by the technology it uses. The social organisation of the actors within the SFS in Indramayu may thus be defined by the actors involved, but also by the specific form of social technology the actors are participating in, i.e. the SFS. Here there is correlation with the first principle of practice theory, where the actors define their "social contours" through "*everyday actions*" (Feldman and Orlikowski, 2011:1241, highlighted as in original). Understanding how the farmers practices are adapting to climate change, and the role that the SFS plays in it, will be analysed from an 'agriculture as performance' perspective. Within this perspective decisions made at the beginning of the planting season do not necessarily define the outcome, rather that the continuous decision making process that is carried out throughout the season are also integral to the farming practices and understanding if adaptations are taking place. There is also a "rejection of dualisms" (Feldman and Orlikowski, 2011:1242, highlighted as in original) within practice theory, which means that the farmers may be adapting their practices to the climate, yet this climate is

embedded within the practices themselves. It rejects the notion that the environment that both facilitates and impedes the scientific and agricultural practices, are treated as two distinct processes. Within practice theory it becomes clear that these practices are embedded within the social and cultural context, that there is a and that they are not only defined by the individual but also by the practices within the wider community.

Complementing the practice theory is that of framing, which is a concept that will be used to analyse the way in which the various actors perceive their participation in the SFS in Indramayu, how these perceptions shapes the way they participate in the collaboration and in turn, how this influences their respective practices. Using the different aspects within Sumberg's (2012) notion of framing, i.e. "the particular contextual assumptions, methods, forms of interpretation and values that different groups bring to a problem" (Sumberg et al., 2012:11), analysis of the different perceptions will be given more focus. These aspects will be described and analysed through the perceptions of the actors within the SFS in Indramayu, as a way of understanding how the various actors perceive their own roles and the roles of other actors within the co-production of knowledge. In analysing the way the SFSs in general, and the work being done in Indramayu, is framed to the wider community, the categorisations of climate change adaptation policies given by Dewulf (2013) will be used. The problem can be seen "as a tame technical problem versus a wicked governance problem" (Dewulf, 2013:324) and "as an issue of state security versus human security" (Dewulf, 2013:325). The frame through which the policy approaches the problem can be seen through one, or a combination of these frames. The delineation of these frames will provide to be useful in analysing the frame that is used to the community outside of the SFS, yet it does not necessarily preclude that the frame will 'fit' in one of the categories of Dewulf (2013). This chapter has delineated what is meant by 'practices', and how they may be analysed, and how the various actors may perceive their practices. To add some more contextual information to the discussion of these theories, the following chapter will describe the farming practices in Indramayu based on the farmers interviewed in the Klub Pengukur Curah Hujan (KPCH) as well as the scientific practices of the scientists at Universitas Indonesia (UI), highlight interesting observations and discuss possible adaptations as a result of their respective participation in the SFS.

Chapter 4: Rice farming and climate change adaptation

Before getting into the dynamics of the co-production of knowledge and analysing the social organisation of the SFS in Indramayu, this chapter will describe and analyse the farming and scientific practices, outlining various issues the farmers are dealing with and then analysing various adaptations that are taking place. From the farming perspective this chapter describes the farming practices, how these practices interact with wider institutions and how the co-production of knowledge is influencing these practices and vice versa. The notion of identity is briefly discussed to reiterate the importance of farming to the club members, while giving a brief introduction into what it means to be a farmer in Indramayu. Moving on to the rice farming practices, this chapter highlights the social and environmental factors that influence the field preparation process, such as the access to the tractors and how the level of water dictates the use of different machines (extensions of the tractor) in processing the fields, and furthermore, when the process can commence. Aside from field preparation processing the fields, the choice of rice variety is discussed as an integral part of the agricultural practices, as well as the management of water throughout the season and their implications for adaptation options. The description does not cover all of the elements to rice farming practices, but narrows the scope to a selection of elements that are the most relevant in relation to possible adaptations to climate change. Once this selection of important facets of the club members agricultural practices has been described and discussed, the practices of the scientists in the SFS in Indramayu will be described. This chapter will outline four main categories of the scientific practices associated with the SFS as the facilitation of members research, the expansion of learning activities, administrative responsibilities, and the scientists own research. These categories are delineated to highlight broadening of practices from the basic scientific principles, to include more applied practices. This chapter starts however, with a brief description on the importance of rice, and that although farming rice is the norm, within the club members there are some anomalies.

Rice farming and identity

"If your meal did not include rice, then you haven't actually eaten"

I'm not sure if you could call this an Indonesian saying, yet it was something a lot of people told me when I said that living in Indonesia had changed my habits and that I was eating a lot more rice. Apparently everything other than a meal with rice, is a snack. Probably a running joke, but it is based on a truth that the staple food crop in Indonesia, and Indramayu is far from being an exception. Siregar's (2010) thesis on Climate Field Schools in Indramayu concluded that a recommendation to the farmers to move away from rice to secondary crops was not heeded, as rice farming is culturally embedded, as well as other institutional constraints such as the irrigation system prevented willing farmers to make the move to other crops (Siregar, 2010; Siregar and Crane, 2011). The club members are thus primarily rice farmers, planting rice in two seasons (rainy and dry season) and some farmers either leave the fields fallow for the remainder of the year during the heat of the summer months or plant secondary crops such as watermelons, green beans, chilis, among others. There are however some exceptions, as two members do not (currently) grow rice and another member's primary production is shrimp. Pak Solihin is a shrimp farmer near the north coast of Indramayu, and although he also has a small field where he grows rice, his main income is from shrimp farming. This poses a slight issue, as Pak Solihin mentioned that he was wondering if his shrimp farming fits within the club at the moment. Most of the discussions are on rice farming

leaving little room for other products, yet indications are there that they also want to take secondary crops and aquaculture into consideration, as Pak Amin noted their importance during the monthly meeting in February.

The other anomalies are Pak Uud, Pak Dadi and Mas Kaeruman, who are personally not managing paddy fields at the moment. Mas Kaeruman is growing onions in his fields, as well as being a student of Law at University near the main city of Indramayu. He has joined the club as he doesn't want to forget his roots as a farmer and wants to help his father's rice farming. Pak Dadi has had to sell his fields due to adverse economic circumstances and now sells goats for a living, although he would like to go back to rice farming someday. Pak Uud has recently moved to Indramayu to manage a swallow barn, yet is interested in growing his own rice, except that renting paddy fields in the area requires a large amount of capital and a lot of the paddy fields will be rented or managed through family ties. These anomalies are given to show that not all the members within the collaboration can be defined as rice farmers, yet the focus of the description of the farming practices will centre itself around the practice of rice farming. As the question of 'identity' came up during the interviews, nearly all of them said they were farmers, while a notable exception was Pak Radiyah who said he was more at home in his shop than working in his paddy fields. Quite a few members who considered themselves farmers, have also diversified into other businesses, such as small shops selling simple necessities, selling pesticides and fertilisers, selling petrol, washing and repairing motorcycles and cars, etc. Pak Kuwu Sunaryo had even become Head of Village in Sumbon (hence the Kuwu in his title), yet it was still very clear that he considered himself a farmer first, then the head of the village. These diversifications increase the members capacity to provide income for their family, but will never replace the rice farming in itself, except in severe, adverse circumstances such as with Pak Dadi, who still feels sad at having had to sell his land and every time he sees rice growing in the field makes him want to grow it himself.

Preparing the paddy fields: machines, water and social organisation

The logical first step in inquiring about rice farming practices was the preparation of the fields for the coming season. When and how does the preparation take place seemed a routine question, and surprisingly unearthed an interesting observation. Comparing the field preparation practices between the villages Nunuk, Sumbon and Karang Layung, there are some clear social and environmental factors that influence agricultural practices in Indramayu. The preparation process is the process of preparing the fields for transplanting, and as seen in Table 2 the ploughing process varies between the different villages, as well as their respective access to a tractor. In Nunuk and Karang Layung the tractors are centrally organised by a tractor manager who makes sure the fields get ploughed in time for the new season. In this system the farmers do not have a lot of control over when it happens, yet they can go and complain with the manager if it is not done on time. Most farmers noted that they did not have to wait and that the manager understood the needs of the farmers. In Sumbon on the other hand, the farmers rely on kinship relations to get access to a tractor. Mas Chandra's father owns a tractor and the various ploughs, which is also used by Pak Kuwu Sunaryo and Pak Radiyah, while Ustad Purnama gains access to a tractor through a cousin. There seemed to be more decision making power in Sumbon due to choosing when to request the tractor from a relation, yet it still does not mean they will have direct access to the tractor as it may be used elsewhere or the owner may be busy at the time requested. Even though in Sumbon they use kinship relations to gain access to a tractor, they also have to pay for the process, which does not differ that much from the centrally organised tractors in Karang Layung and Nunuk. Another interesting observation taken from Table 2, is that there are differences in ploughing practices between the three villages. In Nunuk and Sumbon they both make use of a *wuluku* ('big knife' or

	Nunuk	Sumbon	Karang Layung
When does the preparation process take place?	The ploughing starts when the ***water*** condition is good enough for the soil to be able to plough, as well as for the field to be ready for transplanting according to the stage of the ***dry nursery*** (rainy season).	The ploughing starts when the ***water*** condition is good enough for the soil to be able to plough, as well as for the field to be ready for transplanting according to the stage of the ***dry nursery*** (rainy season).	Not as clear as in Nunuk and Sumbon, as the ***water*** condition is normally very good in the area, prompting a less structured method in preparing the fields. Pak Abas noted that the water should be at least 10cm.
Which machines are used within the preparation process?	***Wuluku*** (traditional plough) to turn the soil and ***leler*** is used to flatten the soil. Possibly also flattened manually later if the farmer does not find it satisfactory.	***Wuluku*** (traditional plough) to turn the soil and ***leler*** is used to flatten the soil. Possibly also flattened manually later if the farmer does not find it satisfactory. In the ***dry*** season only the ***leler*** process is used as the soil is still very moist.	As the soil is already very moist, a ***glebegan*** is used to turn the soil, a cylindrical instrument with blades attached, while a ***leler*** is used to flatten the soil. Pak Kaclek noted that in the dry season they need a ***wuluku*** to turn the soil.
How do they gain access to these machines?	***Centrally organised tractor***. Each paddy block has a tractor and a manager who organises when and where the tractor will be.	***Kinship relations***. Family members or friends are called to gain access to a tractor.	***Centrally organised tractor***. Each paddy block has a tractor and a manager who organises when and where the tractor will be.
How do they gain access to water? In other words, to which agro-ecological zone do they belong to?	***Half irrigated.***	A mixture of ***dry-rainfed*** and ***half irrigated*** fields.	***Irrigated.*** During the dry season the water is pumped up from the canals.

Table I. Paddy field preparation process in three villages, Nunuk, Sumbon and Karang Layung.

traditional plough) to turn the soil before using a *leler* to flatten the field before transplanting in the rainy season. The water condition in the field is the important factor in when the ploughing process starts as the ground has to be moist enough for the plough to be effective. In Karang Layung they do not use the *wuluku* during the rainy season, as the ground is already wet and they use *glebegan* (rotating cylinder with various blades) to turn over the soil and then use the *leler* to flatten the soil. During the dry season in Karang Layung, Pak Kaclek noted that it was dryer and they use a *wuluku* to prepare the fields, while in Sumbon they only use a *leler* to flatten the field during the dry season as it is still very wet. The access to the tractors show how social factors influence on farm decision making, while the type of machinery used shows how practices are being influenced by environmental factors, in this case water.

The use of different machinery may be an interesting insight into how farmers are able to use technology effectively in different situations, yet it is the access to water that is instrumental in the defining the use of these machines that provides a larger conundrum for the farmers. While the change in machinery shows an adaptation to environmental conditions, it is the presence of water that helps dictate when the farmer can start processing the field. In Nunuk and Sumbon the presence of a sufficient level of water is needed to start this process, yet as can be seen with the case in Karang Layung, where there is better access to water, it is not the only defining factor in deciding when to start planting. The access to tractors and having the fields ready for transplanting follows the level of water needed to start the processing, and although both of these factors are instrumental in the farmers' ability to start planting, it does not dictate when they will start planting. The farmers also pay attention to when other farmers start planting as they attempt to plant at around the same time as the other farmers in order to minimise the impact of pests and diseases. The easiest example is that of rats, who will normally impact the farmers fields near harvesting time, and if the farmers have planted on different schedules, the rats will attack the mature fields first, and wait for the other fields to mature before striking again. This causes nearly all yields to fail, while if they plant at the same time the harvesting time would be similar, thus the impact of the rats will be spread across the fields and in turn be minimised. It seems there is no real organisation in when this communal planting should happen, as although it must start somewhere this was never clear, and the impression that was given was that it started haphazardly.

There are thus three sequential processes, shown in Diagram 4, that are seemingly not completely in the farmers control when it comes to deciding when to start planting. This lack of individual control over these events impacts the individual famers' ability to adapt to climate change. The club members may over time obtain the knowledge that will increase their adaptive capacity to climate change, yet the limitations of their own control over certain aspects of their farming practices may inhibit them in enacting on this knowledge. The use of groundwater pumped up from wells to water the fields in order to make processing possible, could solve on issue, but

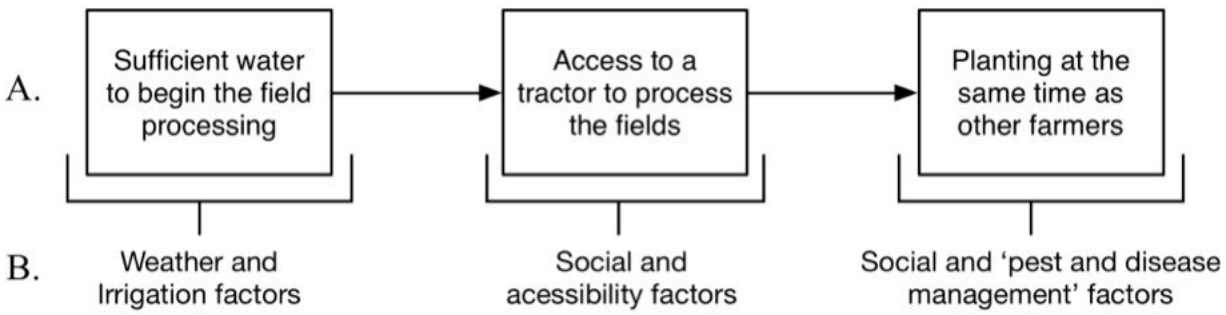


Diagram 4. The three sequential processes (A), and their corresponding (inhibiting) factors (B), that are not entirely within the farmers control when deciding when to plant their crops.

access to a tractor and then sub-sequential planting alignment with other farmers may mean they will lose the advantage given to them by gaining control of their initial water supply (although I did meet one farmer who claimed to be able to supply his crops for a whole season pumping water from a well, this is generally only used as a supplement). Meandering into the world of the hypothetical, if the access to water to initiate the processing could be instigated by ground water wells, owning a tractor would mean direct control over the field processing. Yet it still leaves the organisation of the farmers as the big problem that an individual does not necessarily have control over. The only indication there was of any social organisation throughout this research was in one of the fields of Pak Sunaryo, in Tugu, where his uncle was responsible for announcing when the farmers in the paddy block should start planting. Pak Sunaryo personally had no control over this decision, and said he would have decided to plant earlier in the rainy season of 2012. Most farmers seemed to wait for other farmers, yet for this field, Pak Sunaryo had to follow a hiearchy and thus a specific system, which may be easier to understand and indeed, influence, to fit better with possible adaptations to climate change.

Rice varieties and farmers' choices

The importance of when the farmers plant their crop lies in the coming season, yet planting 'on time' does not necessarily assure crop success. There are other decisions at the start of the season, such as which crop variety is going to be planted, and decisions that are made throughout the season which have a bearing on the end result. During the plant breeding workshop the farmers came up with a list of attributes they looked for when choosing a variety to plant. In the workshop this exercise was done for the farmers to think about what varieties they wanted to breed together to incorporate the important attributes. Table 3 lists these attributes as they are an interesting insight into the farmers mindset when it comes to choosing their variety. Within this list there are two characteristics where have had climate 'in mind' when nominating them. The list is done in order of being mentioned, and that if there was a longer discussion on which had a higher priority, the list would look different. Yet by taking it as a list of characteristics that are in the order of 'the first thing that came to mind', it can be taken as an indication of importance. 'Tolerance to all climatic conditions' is all the way down at 11, seemingly added as an after thought, and with 'Sturdy, the paddy cannot easily collapse when there are heavy winds', it represents one of only two characteristics directly linked with the climate and are both low down on the list. The other characteristics have more indirect links to the climate, with the use of varieties with 'short maturation periods' being a way of capitalising on shorter seasons. This table thus indicates that when it comes to choosing varieties they are going to grow in the coming season, climate does not necessarily rank high on their list of priorities, and that pests and diseases are top of the list.

This does not mean that it does not play a role in the choice of variety, as Mas Runa illustrated when he discussed his variety choosing strategy and that he also used the simple climate forecast to inform his decision. Mas Runas' fields are located in different areas, with different levels in comparison to other fields, and thus some of his fields were more vulnerable to being flooded. Thus if the forecast is that there will be higher than normal rains, Mas Runa can decide whether or not he wants to plant more robust varieties in the fields at a lower level, as the robustness helps them cope better with flooding. At the higher levels that are not so vulnerable to flooding, Mas Runa plants a different variety with other characteristics (such as taste, market value, etc.). If there is little rain forecasted, then all he can do is choose short term varieties to maximise the rain that will fall. This example from Mas Runa illustrates how the simple climate forecast can be used by farmers, and it also shows that the farmers do think about the weather when planting their crops.

Number	Characteristics
1	Brown Plant Hopper resistance
2	Pest and disease resistance
3	Short maturation period
4	Efficient use of fertilizer (minimal use of fertilizer needed)
5	High yields
6	The taste of the rice is good
7	Big seeds, filled well
8	Demand in the market (high profit margin)
9	Easy to harvest with the diesel/petrol powered thresher
10	Sturdy, the paddy cannot easily collapse when there are heavy winds
11	Tolerance to all climatic conditions

Table 3. List of properties the club members regard as important for rice varieties to possess. Numbered in order mentioned during the workshop on Plant Breeding held on the first and second of March in 2013.

So far in this section on rice variety *choice* in the decision making process, it has been assumed that all farmers have access to all the different varieties, yet this is not the case and there are various ways in which the farmers get access to rice varieties. Rice seeds can be bought from shops, traded with other farmers, saved from the previous season, sourced from their own breeding activities and given to them by their farmers groups through a government programme. This list may not be comprehensive, but shows the diversity in how the farmers gain access to their seeds, and these different forms of access have their limitations. Pak Haji Sarma wanted to buy a particular variety of seed, Ciherang, which has proven to popular among farmers, and when checking out the local suppliers the stocks were empty, causing him to choose a different variety. Even having the money and the will to buy a particular variety, it does not necessarily mean it will be available. Trading seeds depends on the availability of the seed you are looking for, and the other farmers interest in their seeds. Using the seeds from the past season limits the choice, and their own breeding programme may not have been successful yet or may not be applicable for the coming season. The governments attempts at supporting the farmers by providing seeds to farmers group, is seemingly a way for the government to promote certain varieties. This opportunity for the farmers is in many cases too good to miss, pushing the farmers to use a variety that may not necessarily fit in the season. These various scenarios sketch that the use of the most applicable variety for the coming season may be impeded by the various ways farmers gain access to their seed varieties.

Picture 5. Muki Wicaksono doing participatory ethnography through aiding the workers in harvesting Pak Hartono's fields. *Photo: Onno Giller.*

Picture 6. Labourers using a mechanised thresher to split the rice from the stalks. *Photo: Muki Wicaksono.*

Picture 7. Muki Wicaksono assisting Pak Amin and Pak Abas in writing the proposal for SAMDHANA. *Photo: Onno Giller.*

Picture 8. Flooding of the fields near Nunuk and Kalensari in the middle of January, 2013. *Photo: Onno Giller.*

Droughts, floods and the irrigation system

"When it rains heavily it floods, when it is dry there is drought" - Pak Kanadi

Mas Runa's example on how he chooses his varieties showed that not only too little water can be a problem but also too much. Pak Kanadi was talking about a field in an area where there is little room for manoeuvre, as when it floods all he can do is wait for the fields to dry, and transplant from other fields or other clumps to repair the damage. When there is a long drought spell, all he can do is pray for rain, as he has limited access to the irrigation canals and pumping up water from an underground well can only be used as a supplement, not as a long-term solution. In Karang Layung on the other hand, they have good access to the irrigation system, especially during the rainy season. This is due to the proximity to the Salandarma Dam, which stands on the border with the Subang Regency, controlling the flow of water into the irrigation canals for a large proportion of the paddy fields in the North-western area of Indramayu. Water can thus easily be controlled by opening the embankment to let water in, and closed when there is enough water. Fields on higher ground have an advantage, as they have a better chance of letting water run from their fields to other farmer's fields when there is too much water and their fields start to flood. With this good access to water, some farmers use a rotation of standing water and no water as a preventative method for pests and diseases, a luxury that farmers with less access to the water do not have. The dry season in Karang Layung started late in 2012, and caused a relatively late planting schedule in the rainy season in 2012/2013 in comparison to villages such as Sumbon, Nunuk and Karang Mulya. Pak Abas put this down to the farmers not being properly organised, as waiting for the others to start planting rather than organising a week together may have been the cause of such a late start to the season. An interview with the water station in Bugis, the main station located near the dam, highlighted that the officers took this late planting into consideration and they left the water gates open for a longer period of time for the dry season.

In Karang Layung it seemed the irrigation system was working well for the farmers, but the behaviour of the farmers up stream in the irrigation system has ramifications for the farmers further down the pecking order when it comes to access to water from the canals. Karang Mulya, home of Pak Haji Sarma, gains access to irrigation water from a different dam, namely the Rentang Dam, located in the Majalengka Regency. An interview at the local water station, Pangamattan Manggungan, with the vice-observer Pak Zaenudin, uncovered that there were various categories along the irrigation canals. The area closest to the dam was Category 1 and the furthest away was Category 3. There was a water schedule brought out by the local ministry of irrigation and water management for the rainy and dry season of 2012/2013. It indicated on which days the canals would supply water to which areas, and for how long. Access to the irrigation water was determined by those making the schedule, as they were in charge of giving the category a 'permit' to gain access to the water. In the dry (rice planting) season, Category 3 (in which this station, and thus Karang Mulya, was placed) did not get a permit and thus no access to the irrigation water. The officer we spoke to said that they sometimes tried to bargain with the other stations up stream to see if they could spare some water, as they felt sorry for the farmers in the area. If there are problems such as a drought, the village officer would report it to the local water station, who would go to the next station up stream, who would report to the next station up stream, until it reached the station closest to the border to the dam, which in this case was on the border with the neighbouring regency Majalengka. At this point a report goes to the main office in the capital, Indramayu, who would get in touch with the office in Majalengka, to see if some more water can be spared. This is only a snapshot of the current bureaucratic system that governs the irrigation canals, but shows that

responses to problems such as drought will be very slow, especially in areas where the source is in the neighbouring regency. In line with the water schedule, Pak Haji Sarma says that his area is very much a dry-rainfed area, where there is only limited access to water in the irrigation canals.

There is a farming practice that could be implemented to try and maximise the use of the limited water supply and one that could help get a higher success rate in the dry season. Locally they call it the *culik* system, and it entails harvesting a corner out of your field early, enough to plant a wet nursery, so that when the rest of the fields are harvested, the new seedlings are ready to be transplanted straight away. This could mean a 1-2 weeks head start in comparison to a more conventional method of making a nursery after harvesting. Pak Haji Sarma feels that this could give the paddy a good chance of surviving as they will have enough water to grow strong enough to survive a large drought spell. The main problem with this method is access to labour at the crucial time, as there is not a heavy abundance of labour available and most of the labourers in the area would rather be harvesting as they get paid a better wage. The other issue with gaining access to labour is that everybody is busy holding big parties as harvesting time is an important cultural event. It was clear that Pak Haji Sarma found this frustrating, yet Pak Supandi, also a farmer in Karang Mulya, felt that the culik method was not going to make such a difference as he felt that the weeks head start was not too much. Regardless of the risks that planting in the dry season poses, most farmers still plant their crops, some decide not to plant at all and a few plant green beans (although it was clear from observations that this also happens in the rainy season, so whether or not these beans replace the rice or not, was not clear). Pak Haji Sarma claimed that only 15 hectares of 400 hectares in Karang Mulya failed to harvest in the dry season of 2012, which included secondary crops, while Pak Didi said that in his farmers group area, the 25 hectares planted with paddy failed, the 20 hectares with secondary crops succeeded while the remaining 62 hectares remained fallow. Maybe Pak Haji Sarma overstated it a little bit, but it remains clear that planting in the dry season is a gamble, as he also added that the crops failed in the dry season of 2003, 2006 and 2012. From my experience it seems that the category that needs the irrigation water the most in the dry season, does not get a permit from the authorities, and it remains a question as what the motivations and ideas are behind the categorisation.

Scientific practices: striking a balance with research, teaching and facilitation

For many of the farmers, interactions with scientists is not necessarily a novel experience. Pak Haji Sarma said that Karang Mulya has been focus for many studies because of its classification as a typical dry rain-fed area, within reaching distance of Jakarta. The sustained interaction with scientists that the SFS offers is far from common, and it counts the same for the scientists. Many scientific projects last no more than a few years, and are not necessarily based on actively increasing the adaptive capacity of farmers. They are more based on researching, and modelling, possible adaptation strategies (see e.g. Thornton et al., 2010), or documenting of existing adaptation strategies (see e.g. Binternagel et al., 2010), in order to inform policy making and/or increase knowledge in the scientific community. The building, and maintaining, of a long-term relationship with farmers requires a change in perception of the scientists role as a researcher, and requires in this case a move to including both teaching and facilitation. Striking a balance between the research activities and the activities that are actively aimed at increasing the adaptive capacity of the farmers, remains one of the more difficult challenges the scientists face when participating in the SFS in Indramayu.

The basic practices, i.e. their research, of the scientists does not change drastically. The process of writing proposals, gaining access to funds, carrying out the fieldwork, and writing reports and articles stays the same. This thesis will not go into the detail about the principles and in-

depth practices of scientific research, but rather assumes the reader has a basic understanding of research principles. This thesis categorises four main areas of activities the scientists partake in when working within the SFS in Indramayu. The first category is the facilitation of the members' research, the second category encompasses activities pertaining to the expansion of the learning process, the third category relates to the administrative aspects within the collaboration, and the final category is the scientists own research. This categorisation is done because they are seemingly different elements of the scientists practices in the SFS.

Facilitating the club members research

In the first category, *the facilitation of the members' research*, the scientists are helping the farmers with problems they encounter during their rainfall data collection and field observations, as well as controlling if the *omplong* is set up properly according to Kees Stigter's requirements. A common problem that is occurring, and one the farmers should normally be able to sort out themselves, is the misplacing of the *omplong* and as it is made of metal it is at times stolen by scavengers (or indeed used by kids for fishing). Facilitating the procurement of a new *omplong* should be done within the club, via the leaders who have a financial overview, and then they can ask Pak Dadi to make new *omplongs* for the farmers that need it. However this does not happen as smoothly, and when the scientists visit the farmers, and enquire how the data collection is going, it is only at this point that it is clear that the farmer is not able to collect data anymore due to lack of an *omplong*. The main activity in terms of facilitation of the farmers research, is the visit of Kees Stigter to Indramayu, when he has a chance to give general and personal feedback to the farmers. Prior to Kees Stigters arrival in Indramayu, he receives the full data sets of all the club members, which were collected since his last visit. The club members also get to send him some questions they may have, and Kees Stigter analyses the data and answers the questions, which he then discusses during his field visit in Indramayu with the farmers directly. The monthly meetings are also a place where scientists are present to help answer questions regarding the research, while some questions that may not be answered on site, but taken back to Universitas Indonesia and either sent to Kees Stigter, or other scientists from outside the SFS approach are asked for their opinion. The networking outside the SFS shop provides a large potential for enriching the farmers learning possibilities, and indeed adaptive capacity. This networking is mainly done by Yunita Winarto, as Kees Stigter said that his network in Indonesia is very limited. So far the networking has been limited to a handful of scientists, but the aim is to expand the base of scientific experts participating in the SFS.

Expanding the learning process

The expansion of the network of scientists contributing to the SFS links into the second category of practices; the activities pertaining to the expansion of the learning process. Prior to my arrival the farmers had learnt about *biopori*, a method of water retention through digging a cylindrical hole and filling it with organic waste, and Yunita Winarto had contacted an engineer focussed on water issues to get some more information on the uses of *biopori*. As part of the programmes for 2013, the farmers made and distributed *biopori* augers to the farmers, with also the aim of renting them to other farmers outside the club. This was done just before my departure, thus the use of the *biopori* is a question for another research. I could personally also be classified as an expansion of the scientific network, and part of my contribution to the club was the organisation of graph and maps workshops with Muki Wicaksono. These workshops will be described in more

detail in Chapter 5 the social organisation in the club, yet the main point was the expansion of the learning process to include visualisation of the rainfall data and observations. The idea of graphs came from the farmers, yet the idea of map making was introduced by Christian Reichel, an anthropologist working on perceptions of Climate Change in Switzerland. The map making was used by him as a tool for understanding how farmers in the Alps perceive Climate Change, yet the club members learnt how to use it as a tool to map the observations in their, and neighbouring, paddy fields. These are a selection of the scientists that were brought in contact with the SFS shop in Indramayu and expanded the learning of the club members. The main additions are the anthropology bachelor students doing their thesis with Yunita Winarto, as they participate within the SFS for the longest period of time outside of Kees Stigter and Yunita Winarto.

Administrative responsibilities

While out in the field it became clear that Muki Wicaksono's and my responsibilities were not restricted to checking up on the farmers research, but also to facilitate the administration of the club, which is the third category of the scientists practices. At the time the club was in the process of getting funds from SAMDHANA, an NGO which among others promotes sustainable projects. In various club committee (the leaders of the club) meetings, Muki and I discussed what the farmers proposed to do with the money, and Muki was instrumental in writing up the proposal and getting it accepted by SAMDHANA. Yunita spends quite a bit of time looking for sources of funding to keep the club running, such as SAMDHANA, and the aim is that the club becomes sustainable through the hiring out of the *biopori*, hiring out of the thresher and hiring out of the water detection device for finding suitable places to dig wells (although it is not clear if the water detection device has actually materialised). All of these were bought with the money from SAMDHANA and aim to generate money to keep the club meetings going. Other than generating income, this requires accurate accounting skills, and as the treasurer, Pak Kuwu Sunaryo, is not very active in the club, Yunita and Muki invariably discuss the accounts with Pak Amin and Pak Abas after a monthly club meeting, when they hand out the monthly stipend to the farmers. Such activities are necessary to keep the club running, but do take up quite a bit of time otherwise used for research, and the commitment to also carry out these activities is needed when participating in the SFS. With more experience, it is possible to transfer a large part of these responsibilities to the club leaders and wider group of members. This is needed if the club is going to become sustainable and when the scientists want to take a step back from their involvement in the SFS in Indramayu.

Increasing the efficacy of applied research

Last, but certainly not least, is the research of the scientists involved. As part of being in the scientific research community, there is invariably a need to publish journal articles, which puts a pressure on the scientists to do high quality research. This means that the scientists cannot devote all their time in facilitating the farmers learning process and actively participating in increasing their adaptive capacity, they also need to carry out research that may or may not help inform the SFS in Indramayu. One of the main aims of the SFS approach is to increased the efficacy of applied research in aiding farmers. The research should thus be aimed at better informing the previous categories of practices described. Most of the publications to date have been on the dynamics of the collaboration between the farmers and the scientists, and describing and discussing farming practices and various other social aspects, based on the scientists interests. Research as a direct result of farmers questions has so far been limited to literature researches, the results of which are

discussed with the farmers during monthly meetings and during Kees Stigters visits to Indramayu. The initiation of field and lab experiments as a direct result of questions raised by farmers has not yet materialised, yet in the future it is possible that experiments and other research will go into the field to help answer these questions. This is one point where the SFS approach has room for improvement, with respect to increasing the efficacy of applied research.

Agricultural practices, scientific practices and the social organisation

This chapter has discussed the agricultural practices of the club members and practices of the scientists involved in the SFS in Indramayu. The agricultural practices of the club members are part of a complex web of social and environmental factors that are embedded in their practices in a way that it may make possible adaptation strategies difficult to implement. The agricultural practices go through an important planning phase, which has implications for and is worked on during the daily activities during the rest of the season, up until and after harvesting. The scientists practices move beyond their own personal research, and incorporate the administrative responsibilities, the facilitation of the farmers research and expand the farmers learning process. The research practices of the club members has not been explicitly discussed in this chapter, as it forms an integral part of the social organisation of the actors in the SFS. The next chapter, Chapter 5, moves on to discussing the member research practices and the social organisation in the field shops, and how the network that has resulted is being utilised by the farmers.

Chapter 5. Co-production of knowledge and social organisation

Being a scholar within the Science Field Shops approach, was both challenging when it came to doing critical research which required myself to step outside of the collaboration, yet on the other hand allowed for interesting insights into how the co-production of knowledge works. It is thus not surprising that the case study chosen to elaborate on the dynamics of the co-production is one in which I was personally heavily involved in. The case study is on the graph and map making workshops, carried out in January 2013, as part of the new programmes set up by the club as a result of funding supplied by the SAMDHANA Foundation. Learning how to make graphs based on the rainfall data, was proposed by the farmers, while the making of maps as a spatial tool for analysing the observations was proposed by the scientists, with the participatory mapping methodology being introduced by a scientist visiting the project. The first part of this chapter will give some background information on how the idea of the workshops emerged, then followed by how they were implemented, before analysing the feedback farmers gave along with the authors own perception on the workshops. The first half culminates in the analysis of the case study, that will aim to give an impression on *how the scientists and farmers [are] approaching the co-production of knowledge that is central to the Science Field Shops approach?*

After describing and giving some reflection on the workshops, this chapter moves on to describing how the network has manifested itself within the Science Field Shops. The long-term interaction between the scientists and the group members, and indeed between the members and scientists within their own 'circles', is an interesting dynamic in understanding how the Science Field Shops may shape if they are introduced in other regions in Indonesia. Within this chapter the dynamics will be described to give a portrayal of what functions the network has and when, where, and about what the different actors have contact with each other. In essence the aim of the second part of the chapter is aimed at helping answer the question: *how are actors socially organising themselves around and within the Science Field Shops?* The social organisation of the actors within the Science Field Shops is closely linked with the co-production of knowledge, and by describing and analysing the dynamics of both a good impression can be given of the mechanisms that underpin the workings of the Science Field Shop in Indramayu.

A workshop in visualising data

Although the monthly meetings are central to the Science Field Shops in Indramayu, it is the special event aspect of the workshops that makes them a good case study for analysing the dynamics within the co-production of knowledge. The idea of the workshops first materialised during a visit by Christian Reichel[1], in which he discussed the idea of the members engaging in (participatory) mapping. The confirmation of the funds being allocated to the club from the SAMDHANA Foundation, gave rise to the possibility of them actually materialising and the workshops were included in the budget. The workshops that were decided on were the workshops on graphs and maps, to be organised by Muki and myself, while the club members themselves organised a workshop on plant breeding. Plant breeding is something some of the members had learnt about before and they were enthusiastic about sharing the knowledge. In this workshop the scientists were mere observers, while in the graphing and map making workshop there was more interaction between the scientists and the club members. To make the workshops more accessible,

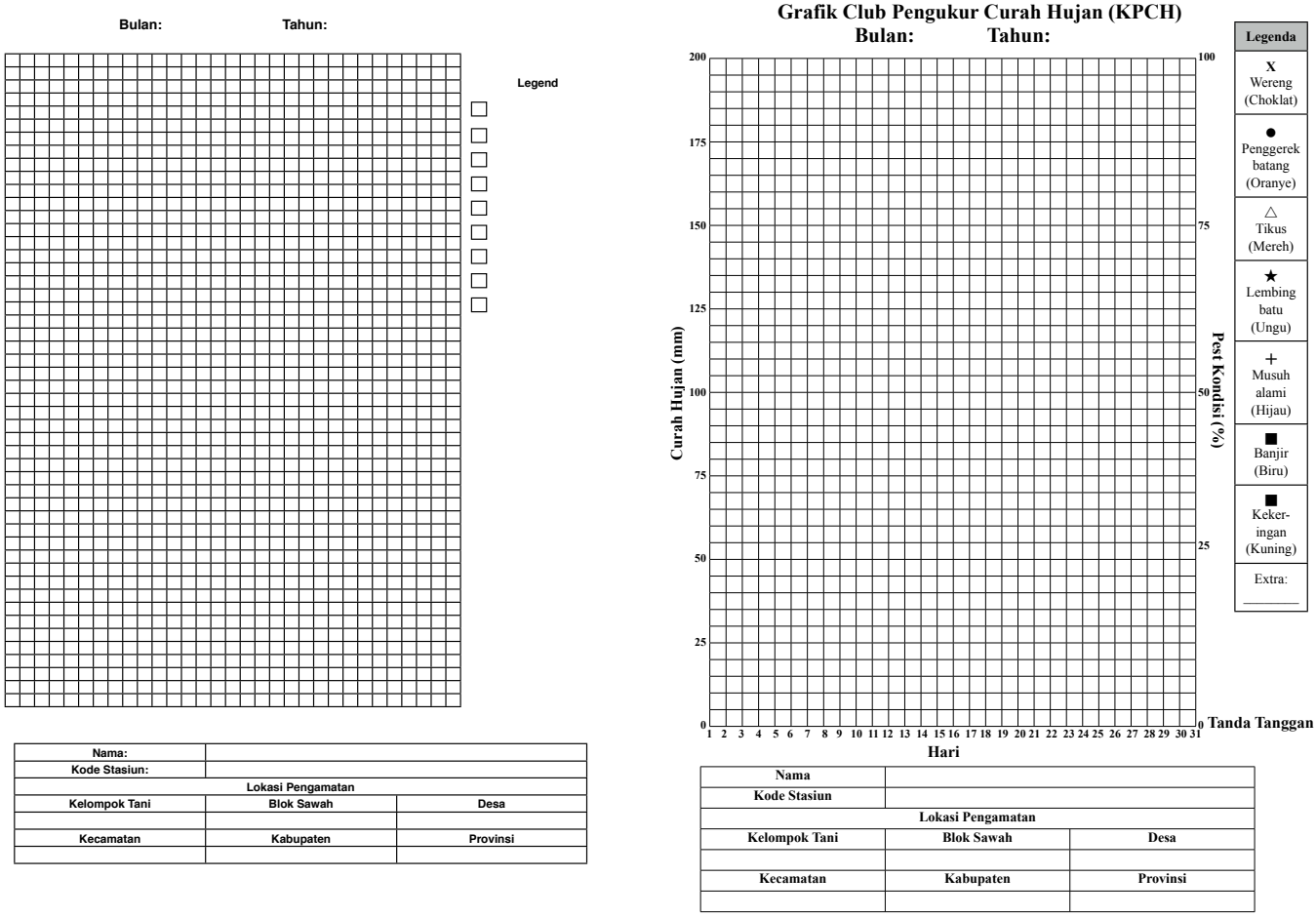
[1] Christian Reichel is a lecturer/research assistant within the Institute for Social and Cultural Anthropology, part of the Freie Universität Berlin. The research he was conducting at the time was "Alpine hazards in times of climate change: Visualization and mapping of local environmental knowledge about alpine risks" (Freie Universität Berlin, 2013)

we decided to make three smaller workshops, which were held in the latter half of January, 2013. The locations chosen were: Nunuk for the Southeastern members, Pekandangan Jaya for the Northeastern members and in Sumbon for the South and Northeastern members. In our first workshop Nunuk we were lucky enough to be assisted by Yunita Winarto, as the workshop in Nunuk had the largest number of members allocated to the workshop.

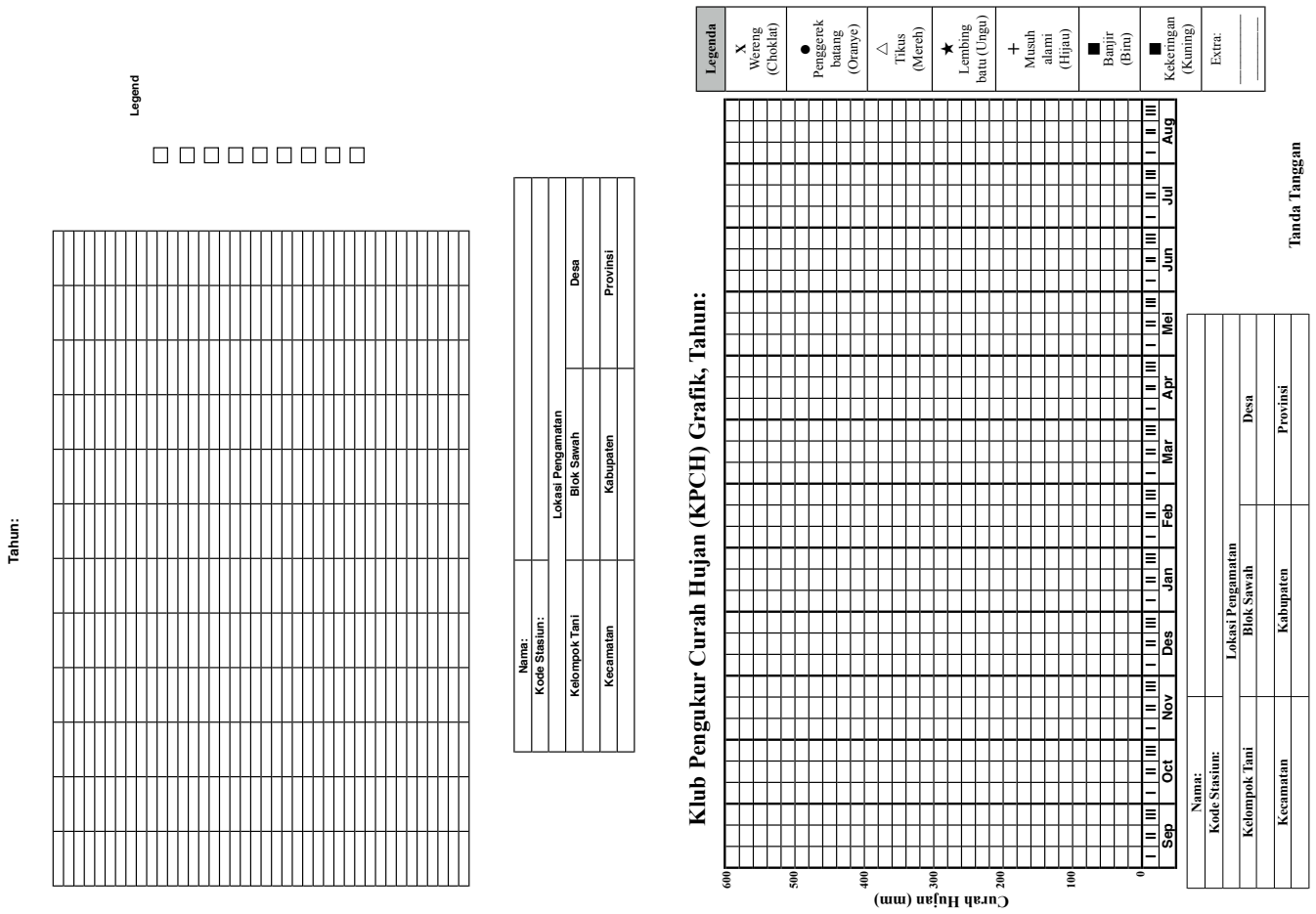
Visualising numbers: making graphs from rainfall data

Pak Haji Sarma played a large role in the first workshop, as he was one of the older farmers who already had extensive practice in making graphs. During the discussion on what indicators should be included in the graphs Pak Haji Sarma was very vocal, yet other farmers also contributed ideas and the changes to the graph template were agreed upon as a consensus, which was important to the members present. We started out the workshop with a basic template, both for a monthly (day to day data) and yearly graph (monthly average data), and it got increasingly complex during the discussions and practice graphs. Throughout the workshops there were some members that found it difficult to know exactly where on the grid to put the rainfall data point, and exactly how to connect the dots to show the fluctuation in rainfall. On the other side there were some members who brought along some old books they had received through the club before, and they showed us some previous attempts at making graphs. We were thus working with a mix of competences, as some had practice making graphs, while some had made some attempts and others had no practice at all. The significance of this is that some of the farmers have adapted really quickly to making graphs on the new templates, while others came out of the workshops knowing the basics (or at least that was the aim) and are still working on honing there skills. In Figures 2 through 7 the build up of templates is depicted by taking the significant steps in the process. The last one made during my time in Indonesia (Figures 5 through 7) showed a move to having a legend on a separate piece of paper to be used for both the maps and graphs. It was done due to the legend becoming extensive and not fitting on the graph templates due to lack of space.

Such an extensive legend will in turn make the graphs complex, and one could go as far as arguing that they will be confusing. From my own experience making graphs, I would say that the farmers are trying to include too many different indicators (diseases, pests, water condition; for extensive list see the legend in Figure 7) and that it could cause some unnecessary confusion and I would recommend them to keep the graphs plain and simple. This was explained to the members, yet it was clear that they wanted to keep all these indicators and as they were the ones making and using the graphs the decision was in their hands. From the initial graphs made in the workshops, and those made in the club meetings that took place after the workshops, it seemed that most of the members had not translated any of these extra indicators (outside of the rainfall data) into visual representations on the graph. When asked about this, Pak Amin responded that he was taking it slowly, and bit by bit learning and trying to add more data to his graphs, by starting with the rainfall data and moving on from there. Although the making of the graphs was not done to the full extent, and at first restricted to the visualisation of the rainfall data, it was eagerly being done by the members and included as part of their ‘homework’ for the club meeting. During one of my final visits to Indramayu, Pak Kanadi showed Muki Wicaksono and I a book he had made, which was a small notebook with square lines, in which he had put monthly graphs and yearly graphs. His graph of his first year as being a member was more extensively portrayed in the yearly graph, adding the prevalent diseases, pests, flooding and drought events. Pak Kanadi also showed some initiative by adding a symbol in his legend for when the harvest took place. The learning by doing hinted at by Pak Amin, is something that is shown nicely by Pak Kanadi, and the template of the graphs and the



Figures 1 and 2. Stages 1 and 2 in the development of the monthly graph template.



Figures 3 and 4. Stages 1 and 2 in the development of the yearly graph template.

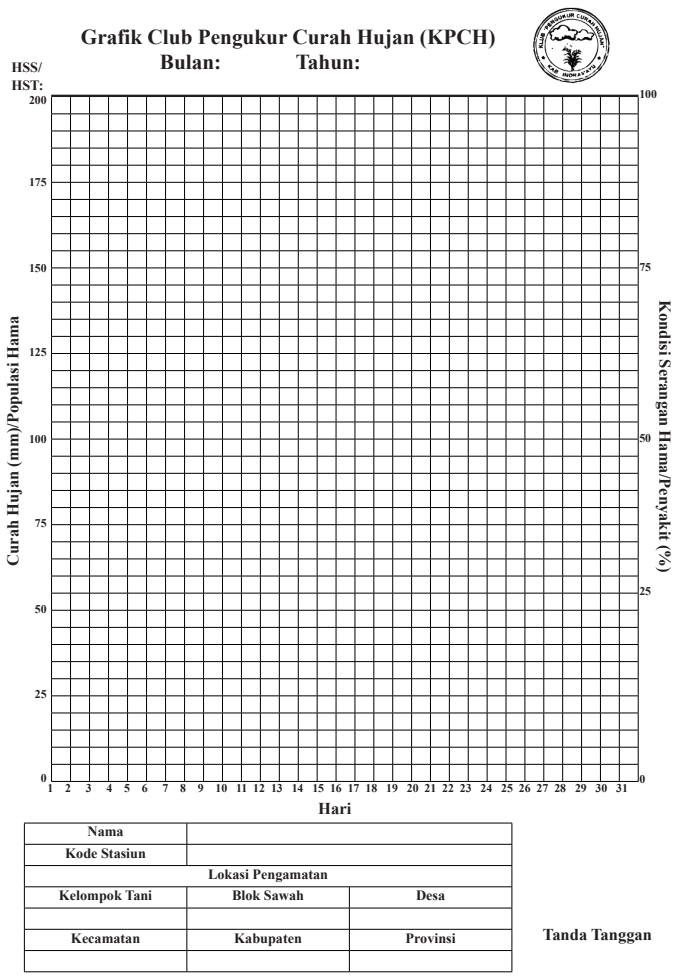
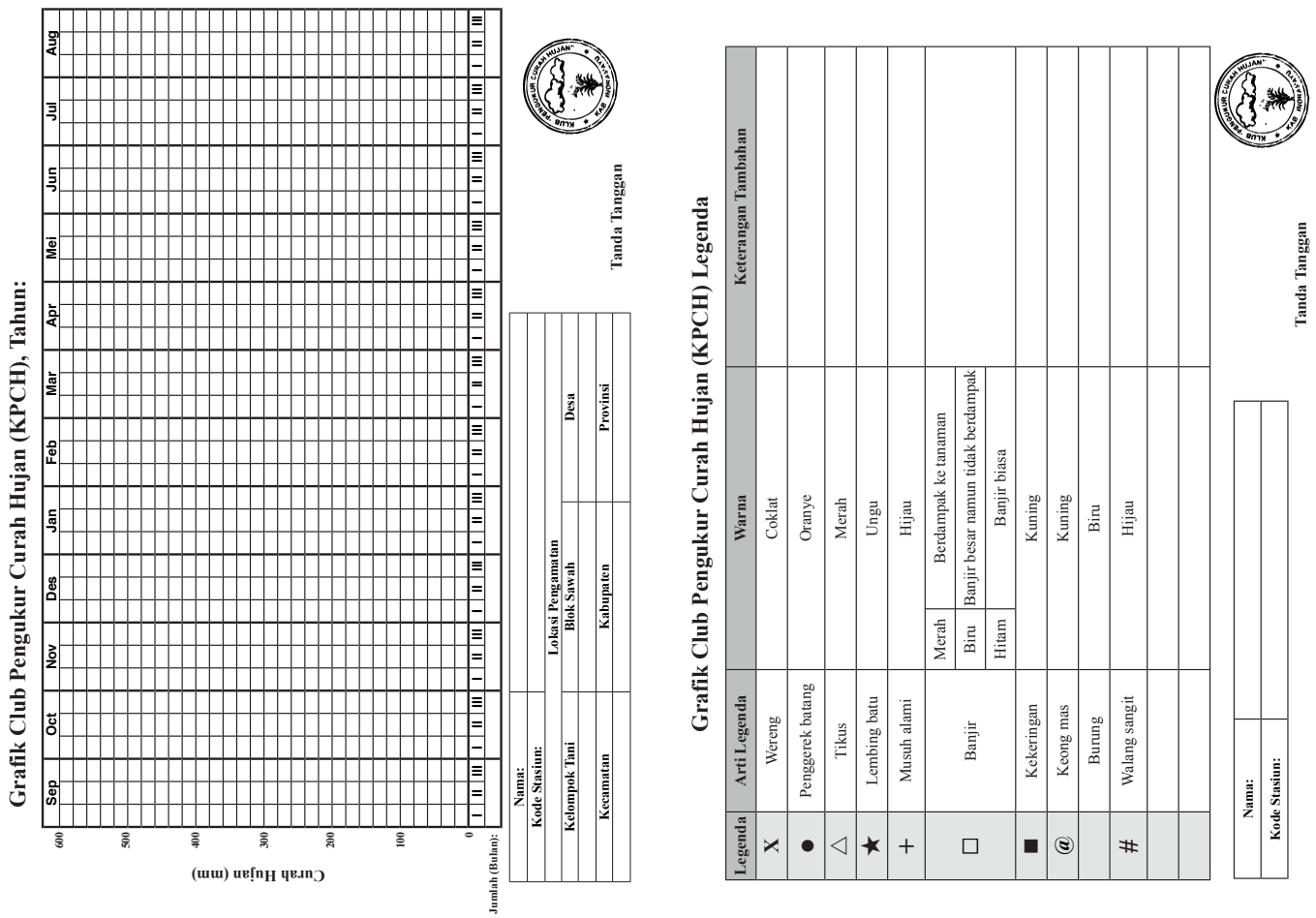


Figure 5. Last monthly graph design made in the development of the templates.



Figures 6 and 7. Last yearly graph and legend design made in the development of the templates.

legend that accompanies them are far from ‘finalised’ and will be continuously worked on, changed and adapted to their own preferences by the farmers themselves.

The enthusiasm with which a majority of the farmers approached the making of the graphs was apparent. The farmers were positive, and noted that the graphs gave them the ability to better understand and read their data than when it was written down in tables in their data books. They also added that after making yearly graphs, or graphs which depict the same month but in a different year, that they were able to do good comparisons with previously collected data. Some farmers added that they were not fully comfortable making graphs and would like some extra instruction. One of the interesting observations was that after a member had finished their graph, they showed it to me to get ‘approval’. A kind of teacher-student dynamic had emerged in which they asked me to have a look at their graph to see what I thought of it, as they perceived me as the expert in making graphs. Pak Kaclek went as far as asking me what grade from 1 to 10 I would give him for his graph. In essence the graphs were theirs, and what should be included in the graphs was down to the members yet when it came to operationalising the indicators (designing the symbols an delineating the parameters) they wanted in the graphs and giving affirmation that their graphs were good was down to Muki Wicaksono and myself. Going back to Pak Amin’s ‘bit by bit’ method, one could see the ‘teacher-pupil’ dynamic lessening once the farmers have had more experience making graphs.

Spacial visualisation: putting observations on a map

The second half of the workshop took a different twist. Rather than only put the data the farmers collected on the graph, an idea was to locate the various, important observations on a map and use symbols to indicate their presence during the last season. To do this Muki and I, with the help of the members, located maps on village level and tried to get them as accurate as possible with the main aim as having them show the paddy blocks (multiple fields) or as accurate as depicting the fields. This proved to be difficult as the authority responsible for the villages maps is the village office, and as it turns out there was no uniform quality in maps. This meant that the members had different quality of maps to work with during the workshop, with members from Jatisura not being successful in acquiring one prior to the workshop and drawing one by memory on site. The reason the quality of maps is important is also due to the methodology used in the mapping technique. We had one copy of the respective map for each village, copied or printed on A3 paper. We cut out clear plastic sheets and bought permanent markers in various colours in preparation for the workshop. The members were instructed to place the plastic sheet over the map and trace the edges with the permanent marker. By using plastic sheets the farmers can compare the different maps they make, as the idea is for them to make a map at the end of each season with which they could compare the maps between the different seasons and between years by placing the plastic sheets on top of each other. The symbols and corresponding colours used to draw on the maps are identical to the ones in the graph, and can thus also be seen in Figure 7. Using these symbols the members can indicate in which areas of their fields, and possibly also the fields they do their observations in, they had problems (flooding, drought, disease and pest outbreaks, etc.). The concept is that the members do it once a season for their own fields, and then meet up at the end of the rainy and dry season with the other members in their village (if there are any) and do a communal map together. In the workshop we decided to get the members to make a communal map with the members in their village, as a way of getting the members to learn and practice together, as well as saving supplies.

The results of the practice were mixed. In the workshop in Sumbon, the members took initiative and just started making the maps without needing any prompting, or indeed any instruction. As they were the last workshop, they were already aided by a legend created during the

first two workshops. One of the main issues that was raised during the making of the maps was the quality of the maps they were working with. Low resolution, especially in villages with a large area like Sumbon, was difficult to work with as members were then forced to work with very small parts of the map and they said they could not properly include all of the issues they wanted to. On other maps they first had to draw the paddy blocks and fields on the map before they could get started. The last issue was the fact that some maps were printed from colour photographs into black and white, which meant that it was mainly black and made it difficult to see the annotations made on the plastic by the members. Rather than disregarding the method, members like Ustad Purnama said they were motivated to draw their own maps based on the original one for the purpose of making the activity easier to do and more productive. The members who made the maps alone had less information to work with and there could be less information to be gained from the maps in comparison to the villages with multiple members, and as a result these members were asked to put in as much information as they could remember from other farmer adjacent to theirs. Pak Sunaryo in Tugu told us that he now aims to pay more attention to the fields in a wider area in order to see how the status of these fields impact his. When discussing the workshops with some members, there seemed to be a mixed reaction to the method. Some members said it was very easy, as they had experience making maps before in other projects, while some members were struggling with it as this way of thinking about their observations was new to them.

Workshops and the wider co-production of knowledge

This section on the workshops on graphs and maps has both implications for the learning part of the SFS, and for the possibility of using the learning to help increase the adaptive capacity. Most of the agricultural practices described in the previous chapter have a very visual mode of analysis for the farmers, and the introduction of techniques to process visual techniques has proven useful for the farmers to understand their own data, and they may be able extrapolate meaning from it for their day to day activities. One of the key points to take from these workshops is that regardless of the competencies and relative understanding, there seemed to be an overwhelming ‘willingness to learn’. This ‘willingness to learn’ is enacted in different ways, and with differentiating levels of enthusiasm. The description of the workshops given above describes in relatively high detail the practicalities of facilitating workshops between scientists and farmers, and the various pitfalls that arise from such a collaboration. The club members have shown initiative in working past such practical issues as they invariably see the usefulness of the tools. The making of the maps has for some club members broadened their horizon and have said they will pay more attention to other farmers fields in their paddy block, in order to understand how issues in these fields impact their own. For both the maps and the graphs, the learning process is far from over, as this was the first step in creating a tool for the club members to use to analyse their own data. The maps and graphs are thus still a work in progress, and and it may take some time for them to increase in quality and then turn into a reference point within the agricultural practices of the club members. The initiative to remedy practical issues and the imagination used to adapt the tools to fit their own ideas, shows a potential for the club members to both initiate their own adaptation strategies, but also the willingness to consider adopting adaptation strategies proposed by scientists and policymakers.

The maps and graphs also provide a good platform for scientists to identify possible vulnerabilities in farming practices with the club members. By visually being able to indicate issues they are facing on-field, and through discussion being able to identify off-field factors that may be facilitating or hindering their on-field activities. Looking through a more scientific lens, the graphs that materialised are too complex. This is where teaching ends, and facilitation takes over, as a ‘top-

down' teaching method promoting the only good use of the graphs in accordance with scientific principles will not promote the making of, and using of the graph. A bit of flexibility is needed, and it may prove in the future that the farmers find them too complex and only end up using a couple of indicators, yet the possibility to put all of them in gives them the freedom to shape the graphs to their own requirements. This freedom will hopefully promote the adoption of the graphs and maps as a tool in the club members farming practices. As indicated in Chapter 4, the workshops are where the scientists are trying to help expand the learning processes of the farmers. The scientists stepped out of the boundaries of the (participant) observer, to actively changing the interactions and dynamics that are being researched, and even to an extent becoming central to ones own research. Actively participating in the learning process of the club members gives the satisfaction of being able to share some knowledge that may prove useful in increasing the adaptive capacity of the members. It also requires a certain level of reflexivity in terms of impact on ones own research, as well as re-visiting the maps and graphs with the farmers to see if they are using it, and what problems they may be facing. Future research is needed to see if the graphs and maps are actively being used within their farming practices and increasing the on-farm adaptive capacity.

The Science Field Shop in Indramayu: the network.

The maps and workshops are a 'special event' in the club calendar, and these special events give a good indication on how motivated the farmers in participating in the co-production of knowledge. The workshops had a high attendance rate, with only 2-3 members not turning up for various reasons, and Pak Haji Sarma and Pak Nurkillah even turned up to two workshops. The attendance in the monthly meetings is also high, and looking outside of the key requirements of being a member, the motivation to learn and to do the research associated with it, there is also the reimbursement of transportation costs given at the end of the meeting. Other events which had no cover of transportation costs, such as the meeting with Irene Koomen which gave the members a chance to ask about pests and diseases, had lower attendance levels. Pak Kanadi was rather cynical about such proceedings, as he said that "if you want to organise a meeting with farmers in Nunuk (his village) and you provide food or some kind of compensation, 200 out of 200 will show up. If you do not provide compensation or refreshments, only 5 will show up." Pak Haji Sarma noted that this kind of behaviour within farmers is according to him due to the large amount of projects in the area run by the Government, NGO's, among others. They have all given compensation for participating in their project and/or provided the farmers with material, technical assistance such as pesticides, fertilisers and rice varieties. This is a reality, and financial gain from participating in the collaborative research may be part of the motive for some of the members. Yet there are two sides to the coin, as those that do the research and come to the meetings because of the monetary compensation will also be exposed to the learning process and gain benefits from it, and possibly even gain more motivation to participate in the collaborative effort. The monthly compensation is also deemed necessary because the distance between the different members can be large and as the monthly meetings rotate between farmers it can be a financial strain to some of the farmers to make it to the meeting. It would be thus a pity for those highly motivated, but less well off financially to then not be able to take part in the club.

The Klub Pengukur Curah Hujan members network

The financial aspect is the main reason given for why the membership is limited to around 50 members. Asking the leader, Pak Amin, and the secretary, Pak Abas, in the club what the criteria is for joining the club, they say that the main requirement is that they are motivated to learn and will

carry out their research properly. In theory there is no limit to how many members can be part of the club, yet in practice there are constraints to how many member they can support. Membership fluctuates due to the members leaving for various reasons (illness, busy schedules, switching profession) and members joining. In Diagram 2 in Chapter 3, page 18, the members location are displayed according to an old membership roster, yet still gives a relative accurate impression of how the members are distributed throughout Indramayu. Getting across Indramayu and to the more remote villages takes a good part of the day as the roads can be bad quality, and the versatility of the motorbike that the members drive is key in navigating their way around the regency. Due to the expenses of gasoline and the time limited by otherwise busy schedules organising their farms, the face to face meeting of members outside of their home village is minimal. Diagram 5 depicts the network within the members of the Klub Pengukur Curah Hujan, with the centre being the most frequent modes and space for interaction between members, making it's way out to the interaction between the members and farmers who are not part of the club.

While writing the proposal for the research the visualisation of the network was theorised to be an interconnecting web of actors and actants which could be mapped out in a diagram. In practice this proved to be difficult, as trying to note down succinctly who had discussed with whom and through what medium proved to be sufficiently difficult, and did not necessarily accurately portray the dynamics of the network. Diagram 5 shows a more accurate interpretation of the network between the members the Klub Pengukur Curah Hujan. Central to this network and the main space for interaction between them are the monthly club meetings. In these monthly club meetings they get to meet the other members, discuss their research and other farming practices as well as socialise and do business. Outside of these monthly club meetings the members tend to meet up with and contact the members who are close to home, the closest of which are those in their own villages. The close proximity means they may already have social ties. In Nunuk nearly all the members are part of the same farmers group, Lamaran, and Pak Kanadi, Pak Nurkillah (moved to Pekandangan Jaya from Nunuk) and Pak Dadi are related to one another. Another social link that spreads throughout the network is the fact that most of the club members are also members of the IPPHTI (IPM-FFS Alumni Group), which is a legacy from the initial collaboration with IPPHTI before the relationship between the UI team and IPPHTI broke down. These various social ties, both local and throughout Indramayu may have already existed prior to the Klub Pengukur Curah Hujan, while some members have created new friendships and social ties after joining the club. A few of the members interviewed expressed that the social network and being able to learn from more experienced farmers was a reason for joining the club. The members who meet up and contact each other more regularly are the leaders within the club, Pak Amin and Pak Abas, as they have to organise the budgets and other activities in club. Pak Kuwu Sunaryo, the listed Treasurer was hardly ever present at these meetings as he was too busy being Head of Village in Sumbon and managing his own farm.

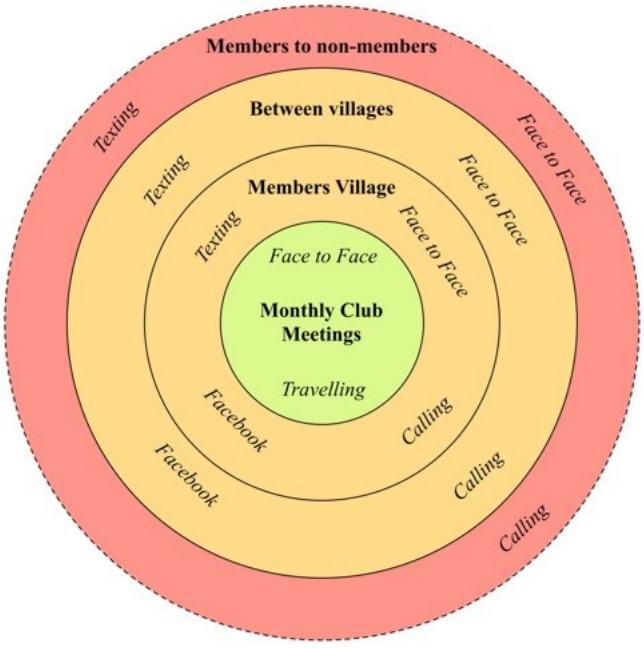


Diagram 5. An interpretation of the KPCH members network

The contact outside of the monthly club meetings is mainly done through mobile phones, as all farmers have access to at least a

simple phone with the ability to call and text. Topics of conversations mentioned are calling or texting to see if the other member is coming to the monthly meeting and how much rainfall they measured in the morning. Club members invariably call each other or text each other with the rainfall they may have collected that day, especially if there are large amounts, or if they are annoyed that they have not had any rain for a prolonged period of time. This exchange of rainfall data can be a method of social control, to see if other members are also doing their data collection, as well as keeping themselves motivated to collect the data. This data is also central to the monthly meetings, and there is a second control taking place when they hand in the data sheets, as the scientists check for each month who has handed in the data. If there were data sheets missing, Muki sent the members whose data sheets were not handed in a text to ask them to hand it in at the next meeting.

Other topics outside of 'club business' are of a business or a social nature. Only a few of the members interviewed were actively texting, calling and yes, contacting other members via Facebook. Some farmers such as Pak Kanadi, cited that having limited access to mobile phone numbers is the reason why he does not contact other members from other villages outside of the club meetings. Pak Dadi is an example of somebody who travels quite a bit to buy new goats and sell goats for his goat rearing business, and through his travels he also drops by other members to say hello. Pak Dadi also has business with other members, as we met him once at Pak Nurkillah's house he told us he had just been to the capital of Indramayu, aptly named Indramayu, to sell mushrooms for Pak Darsono, a member in Jatisura. The network is also used as a social support network, as Pak Haji Sarma has had capital problems and had been to see other farmers to get some financial support. Another member had family problems and his wife had left to Jakarta in preparation of going abroad to work as a foreign labourer. The member had given his wife permission during an argument with her, and did not know which agency she was using. He contacted Muki and myself about it and Muki ended up helping him locate the agency and his wife, yet this poses dilemmas for scientists as this is getting too far involved with the members lives outside of the SFS activities. Then again, not helping can be extremely difficult and striking a balance is necessary if it is not to get out of hand.

The team of scientist's network

The example of the member in trouble and Muki helping him out, is one way of interaction between the scientists and the farmers, yet before I get into the interactions between the scientists and the members of the Klub Pengukur Curah Hujan, I will describe the network from perspective of the scientists. In keeping with the diagram describing the member's network, Diagram 6 shows the network from the perspective of the team of scientists based at Universitas Indonesia. The main space for interaction between the scientists is at the university, specifically the Department of Anthropology at Universitas Indonesia, within which they are based. One of the scientists, Kees Stigter, is based abroad and only visits Indonesia for a limited time each year and most of the contact with him goes through e-mail and skype. The second space in which the scientists meet is the monthly meetings with the members, which other than providing valuable time to interact with the members, also provides time to discuss with each other as well. The travelling to the club meetings from campus normally takes a considerable amount of time, either on the train or with the car and this time can be used to discuss the upcoming meeting as well as other issues. The third space for interaction, is the fieldwork aimed at collecting data for research and visiting the members to see how they are getting on. This was generally a space for Muki Wicaksono and I to interact, as Yunita Winarto and Kees Stigter did not join us on these field trips.

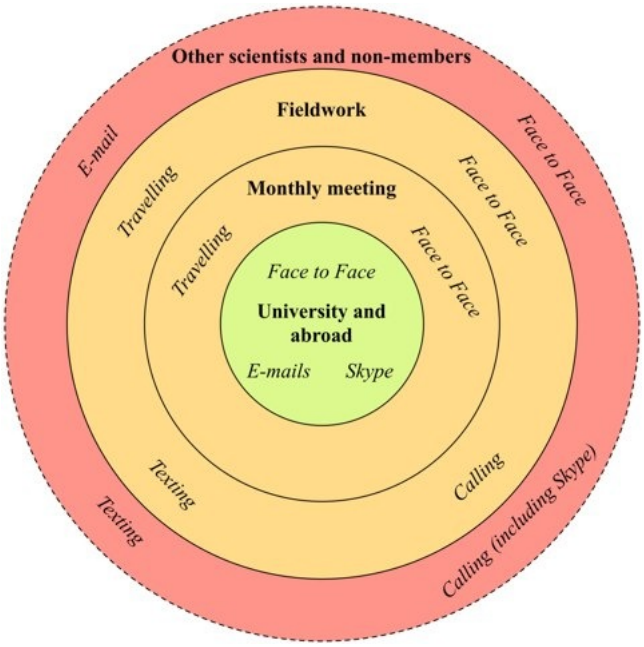


Diagram 6. An interpretation of the scientific team's network

The main content of the interaction within the scientific team was the progress of the research, the member's research and the club's wider activities such as the finances and workshops. Yunita Winarto's role as a thesis supervisor for Muki Wicaksono, meant she spent quite a bit of time talking to Muki about his research and the progress he was making. Yunita Winarto was also my internship supervisor, and she checked up with us on both mine and Muki Wicaksono's responsibilities towards the running of the club and the club member's research. As the principal scientist based in Indonesia, most of the contact with Kees Stigter went through Yunita Winarto.

The final ring in the diagram is the connection of the team to their wider networks within the scientific community. The visits to the field by Christian Reichel, Irene Koomen and scientists from the communications department of the President University, are examples of the use of the scientist extended network to introduce experts to help answer farmers questions. Christian Reichel was interested in visiting the project and introduced the mapping method, while Irene Koomen is my mother and was interested in visiting some of my field sites. During her visit, we organised some meetings in which the farmers could ask questions about pest and diseases. The exact role of the communications department of the President University is still unclear, although they were out in the field to get more experience in field work and the possibility of working with farmers. This outer ring is also through which I was able to join, as contact between Kees Stigter and Yunita Winarto with my supervisor, Todd Crane, gave me the opportunity to participate in the collaboration both as an intern as well as for doing my own research for this thesis. This outer-ring is also where Yunita Winarto does most of her searching for extra funds to keep the collaboration with the farmers running, such as the contact with SAMDHANA which provided the money for the farmers to continue organising meetings in 2013, and with any luck, it can help provide money for the upcoming years as well.

The Klub Pengukur Curah Hujan meets the team of scientists: spaces for dialogue

The key space in which the scientists and club members interact is the monthly club meetings, in which they meet regularly in person to discuss the data collected over the past month. In most cases this mainly involves the data collected by the farmers, but sometimes issues raised by the scientists are also discussed. Other topics were observed, such as the introduction of SAMDHANA as a possible donor to the club so that the monthly meetings could continue. SAMDHANA's aim was for the club to become sustainable in it's finances and various business ideas were proposed, one of which was the investment in a thresher which could be rented out for the harvesting period. Whether or not these ideas will be successful in keeping the club up and running in the future remains to be seen, but the 'executive' meetings between the club leaders, Pak Amin and Pak Abas, with Muki and myself showed an interesting dynamic between the club and the scientific team. The 'executive' meetings showed that there is a stronger link between the club leaders and the scientists, than there is between the scientists and the rest of the club. There is more

Picture 9. Pak Dadi measuring rainfall in his *omplong*. *Photo: Onno Giller.*

Picture 10. Pak Haji Sarma announcing his research results for the month of January at the meeting at Pak Akmad's house in Kertawinangun. Pak Abas is taking notes. *Photo: Onno Giller.*

Picture 11. Workshop 2 on maps and graphs, held in Pekandangan Jaya. Pak Nurkillah is explaining while Muki Wickasono is taking notes. *Photo: Ubaidillah Pratama.*

Picture 12. Christian Reichel visiting the field in Amis, accompanied by his girlfriend, Yunita Winarto, Pak Karwita, Muki Wicaksono, Pak Dirham and another farmer. *Photo: Onno Giller.*

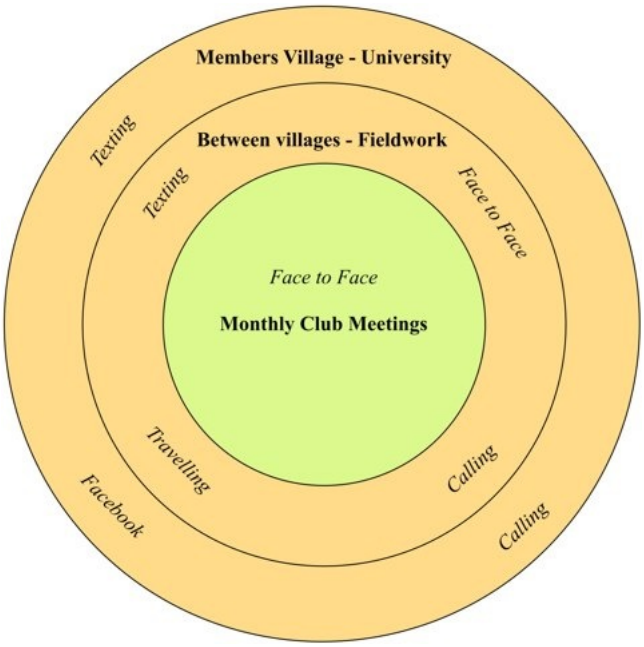


Diagram 7. An interpretation of how and where the networks of the scientists and the members interact

communication and contact with them simply due to their responsibilities to keep the club in good condition. Nearly all of the decisions made by the leaders are results of discussions within the club meetings and they also take into consideration the advice from the scientists on certain issues. At times scientists also help make things into reality, as Muki both created the proposal for SAMDHANA, in discussion with the leaders, as well as making sure the accounting was up to date and that the next monthly instalment of the funds from SAMDHANA would come through.

Outside of the monthly club meetings, one of the most intensive contact between the scientists and the members is when the scientists travel to the field to carry out their research. The interviews, field visits and discussions are another part of the interaction that can be both valuable to the farmers and the scientists. One member told me that through the discussions with Pak Kees (Kees Stigter) and answering questions Kees Stigter was asking them, it was easier for him to remember what had happened and think about it than when nobody discussed certain aspects of his farming with him. When the scientists are back at the University there is only limited contact with the farmers. Pak Amin and Pak Abas have relatively regular contact with Yunita and Muki, as well as Pak Haji Sarma and Pak Dadi mentioned they had contact with Yunita outside of the monthly meetings via text messaging. Contact with Pak Kees was deemed impossible as he cannot speak Bahasa Indonesia. This language barrier is something that continues to hamper my Facebook contact with the farmers from the Netherlands.

A large proportion of the interaction between the scientists and the leaders of the club is thus of administrative in nature, yet contact with the club members in general is on the rainfall data collection and the observations from the field. The knowledge that is generated from the discussions between the scientists and members aims at increasing the adaptive capacity of the farmers, and increasing the understanding of farmers vulnerabilities by the scientists. The discussion can result in suggestions on how to deal with various problems, such as water control and pest and disease prevention. These suggestions can be used by the farmers who are experiencing difficulties in these area in order to improve their practices. In the discussion, some questions arise that cannot be answered straight away, and further research by the scientists or contact with Kees Stigter is necessary to give an answer and propose possible solution. This further research is currently based on literature searches, but can in future result in topics for extensive field research.

The simple climate change forecast

One of the main transmissions of information throughout the network of the SFS in Indramayu that provides a topic for interaction between the scientists and members, and is aimed at actively providing a service to help increase the farmers adaptive capacity, is the monthly, simple climate forecast. To keep the club members' up to date with the climate forecast for the coming months, a simple climate forecast is spread throughout the network in the Science Field Shop, and

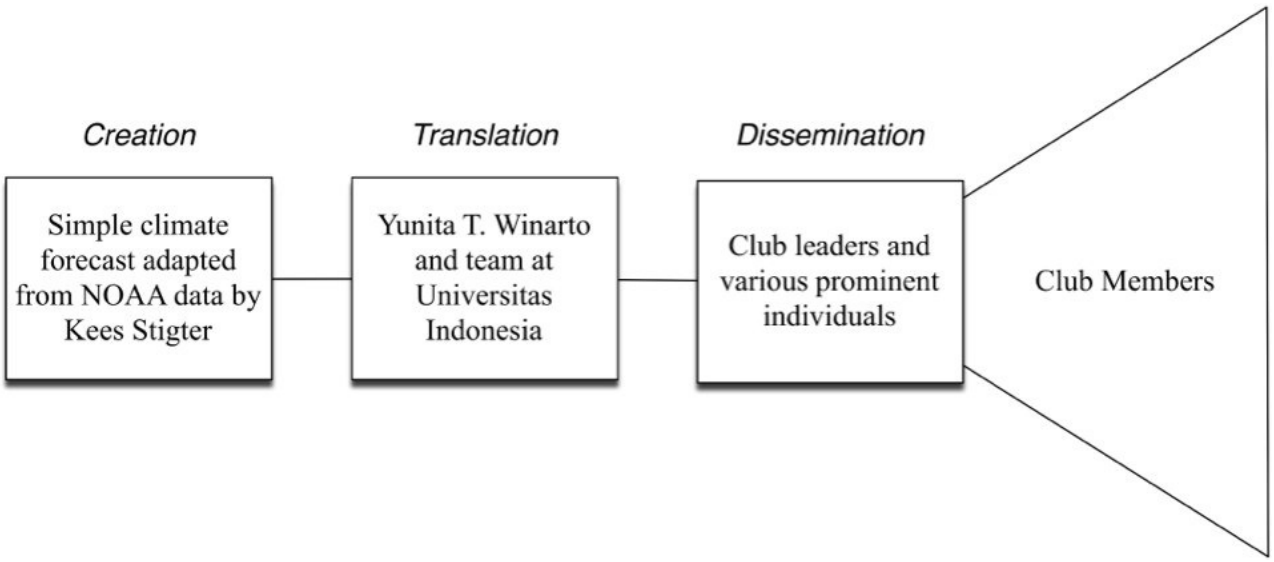


Diagram 8. The creation, translation and dissemination of the simple climate forecast within the network in the Science Field Shop in Indramayu.

is one way in giving extra information in the order for farmers to make more informed on-field decisions. Before describing more in which ways the farmers use the simple climate forecast, the process in which it is created and spread throughout the network will be introduced. In Diagram 8, the process through which the forecast is generated and communicated is depicted. The initial step is where Kees Stigter adapts the complex forecast by the National Oceanic and Atmospheric Administration (NOAA) into a simple format, which he sends via e-mail to Yunita Winarto and her to at UI. Yunita Winarto, with some dialogue with the other scientists, then translates the forecast, before sending it to leaders and various other more prominent members via text message, from where it is distributed to other members in the club. This system had some flaws as not all of the members received the forecast, and thus a more structured plan was drafted where there are three members responsible for disseminating the forecast to an assigned list of farmers. This did not go too smoothly in the initial months, and the dissemination of the forecast is still being worked on. The members that did receive the forecast had mixed feelings about it. The forecast on the whole revolved around the word 'normal', where the rainfall was going to be normal, above normal and below normal. The perception on what normal meant varied, with some answers stating concrete rainfall numbers, some describing rainfall events and other stating they did not really understood what was meant by it. Even in their description of rainfall events and rainfall numbers, these varied per member, indicating that there was a variation in interpretation by the members. This was made even more complicated due to difficulties in the translation, which could at times make the forecast confusing. The forecast in itself did not give an advice to the farmers, it stated the probabilities of the climate over the coming three months. Discussing the forecast at the monthly meetings, and what it could mean for their respective farming practices, is a key moment in making the forecast more relevant than just a piece of information. This is where Kees Stigter says it actively becomes a 'service', when there is dialogue between the actor who is giving the advice or information and the recipient actor. Without it the advice or information loses a large proportion of its prospective usefulness.

The forecast was used in various ways by the members, where one of the main ways was comparing it with the rainfall data the member had collected to check the accuracy of the forecast. Various members were interested in collecting rainfall data and observations in order to compare it to the existing *Pranata Mangsa* (derived from the javanese lunar calendar) and the climate change forecasts, and Pak Kanadi was very interested in then being able to make his own climate change

forecasts based on this comparison. For Pak Haji Sarma in Karang Mulya, this could mean a more informed decision as to whether or not he will plant rice in the dry season, or rather leave the field fallow or move to secondary crops. In the dry season of 2012, Pak Haji Sarma received the climate change forecast from Pak Kees, which stated that there was going to be less than normal rains and possibilities of an extended drought period. Based on this information, Pak Haji Sarma told his fellow farmers not to plant this season as it was going to be very dry and the crops would fail. Two days of relatively heavy rain, prompted Pak Haji Sarma to think that it might rain after all and he decided to plant rice after all. As it so happened this rainfall event was an anomaly and his crops failed miserably due to lack of water, with no harvest possible and in turn a large loss in capital. One of my last interactions with Pak Haji Sarma was on the brink of the dry season of 2013, and with a very similar climate forecast, which left him with the same dilemma as that in 2012. What his decision was for the 2013 dry season is not clear, but previous experiences do not necessarily dictate the future as the climate forecasts can be wrong. The only member who was concretely using the climate change forecast in their decision making process was Mas Runa, when choosing the variety for the coming season, which was described earlier in Chapter 4 in more detail.

Co-production of knowledge and social organisation

One of the key pieces of knowledge that was discussed, and that has become embedded within the network that has materialised in and around the SFS in Indramayu, is the simple climate forecast. The monthly update on the forecast is part of the scientific contributions to the club members research and is discussed to an extent at the monthly meetings. These same meetings are the central part of the network that has evolved between the Klub Pengukur Curah Hujan and the team of scientists from Universitas Indonesia. The monthly meetings are a regular event in which the members can meet face to face with other members, as well as the scientists, and it is one of the best places to discuss the research and it's implications for their fields. When back in their home village, the members contact with other members is restricted, and the majority of their contact with other members is those who live in close proximity, mainly their own village. Some members have more contact with other members via mobile phone and facebook, while some say that they rarely meet up with other members. The scientists do most of their internal discussions at the university based in Depok, as well as contacting Kees Stigter via e-mail and skype as he is based abroad. The monthly club meetings are another space in which all the scientists meet up for discussion, yet for the scientists who go on fieldwork together this creates an even more intensive environment to discuss and gain more insights into the workings and possible failings of the collaboration.

The social organisation can be seen as a series of spaces in which the members and the scientists can interact, with the main reason for interacting with one another being the co-production of knowledge. The workshops were one of these spaces, and showed that on both sides of the collaboration there is a drive to advance the learning process of the members. The maps were introduced by the scientists as a possible method to do this, and it was made possible through utilising the wider network of scientists interested in climate change. The graphs on the other hand were introduced by the farmers, and showed an interest in portraying their data in a different way and giving them an ability to show their data more easily to other farmers. The maps and graphs are in essence methods to increase the members ability to analyse and discuss their data. This activity is a key part of the monthly club meetings and it may increase the productivity of these meetings. The dynamics and participation in the monthly meetings will be a key space of an SFS that is planned to be implemented elsewhere, and through these dynamics, more opportunities will emerge to organise extra activities such as the workshops on plant breeding and graph and map making.

Chapter 6. The framing of the Science Field Shop in Indramayu

In a long-term project such as the collaboration between the scientists and the club members in Indramayu, the way the participants are framing the work they are doing, and how they are portraying this work to the outside world, can provide insights into why this specific approach is being used and how the framing has shaped the outcomes of the project. During the data collection, gaining an insight into how the various actors perceive the respective roles in the collaboration and how this collaboration is framed to the wider (scientific) community, was done both through interviews, observations and analysis of various publications connected to the Science Field Shops (SFSs). This chapter will first look into the recent changes to the conceptualisation of the SFSs, before looking into how the different roles in the collaboration have been framed by using Sumberg's (2012) notion of framing. It then moves on to describing how the collaboration is portrayed to the wider community, and analysed using Dewulf's (2013) categories of framing within climate change adaptation policy. The main aim of this chapter is to answer the sub-research question, *how do the various actors perceive their participation in the co-production of knowledge and how is it framed towards the wider, international community?*

Conceptualisation of the Science Field Shops

Pak Amin, in discussion with Yunita Winarto, said he wanted to join in the project if it was not going to be something temporary, to which he said Yunita responded that her aim was to keep it going for at least 25 years. Comparing conceptualisation of the SFSs in a recent paper published by Stigter and Winarto (2013), with the book written ons the SFS in Gunungkidul (Winarto and Stigter, 2011), there is a distinct change in the proposed outcomes of the SFS. In Diagram 9, an excerpt of the diagram[2] made in the book is given, which indicates that one of the outcomes of the SFS was to create improved, more informed, Climate Field Schools (currently a top-down, government run, teaching programme). In a recent revision of the SFS approach, they have abandoned the idea of linear teaching to farmers, and instead use the improved Climate Field Schools as a way of (re-)training the extension officers to provide a better, applied service than they currently do. Rather than only training extension officers, they also aim to train farmer facilitators to be able to do the same job, and possibly work in conjunction with the government run extension service. To be clear about what is meant with 'service', Kees Stigter explained in an interview his differentiation between information, advisory and services. Information is a mere statement of data, while an advisory is where an advice is given on the basis of this information, and only when there is a

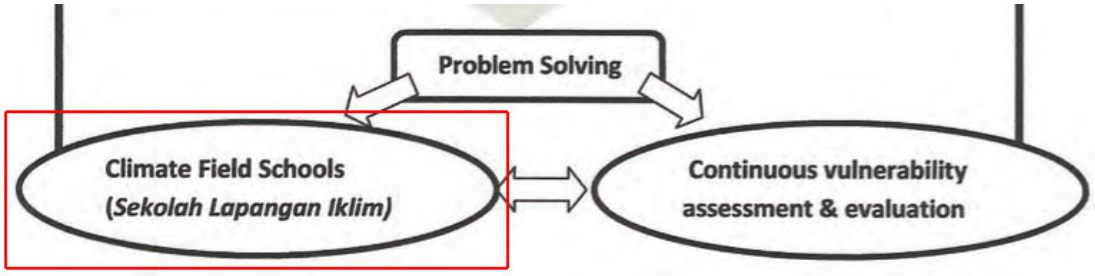


Diagram 9. The Science Field Shop approach, reprinted and adapted from Winarto and Stigter (2011:222).

[2] Can be seen in full in Chapter 2 of this thesis, on page number 12.

dialogue between the creators and recipients of the advisory about it's contents does it become a 'service'.

Thus the change in framing is that the only linear, 'traditional' teaching is proposed for the extension intermediaries and farmers facilitators, and that the information that reaches the farmers in the form of a service, as in these trained intermediators participate in a dialogue with the farmers about the information they are giving the farmers. The SFSs in this new diagram is set with the "educational support "tree"" (Stigter and Winarto, 2013:116), and is presented in line with the applied agrometeorology, in which there is a joint assessment of vulnerabilities and search for solutions to these vulnerabilities, by the scientists, farmers and the extension intermediaries. It is also proposed in the latest conceptualisation that "well-trained extension intermediaries [...] should over time take over most of the tasks of the scholars in the "SFSs"" (Stigter and Winarto, 2013:115), which then sees university scholars take a step back from the field but are still there to provide support and train more extension intermediaries. This change in framing shows that the SFSs approach is actually going further in the notion of providing support services for the farmers. Farmers are thus seen as experts in their own context but are in need of information science can provide them to improve their practices in light of climate change (among other issues), as well as that science needs to increase it's usefulness by using feedback from the field to research more applied agrometeorology.

Roles of the actors within the Science Field Shop in Indramayu

The conceptualisation of the SFSs at a higher level, does not necessarily determine the way in which the actors participating within the SFSs are framing their respective roles and what they expect the collaboration to focus on. In essence, "the particular contextual assumptions, methods, forms of interpretation and values that different groups bring to a problem" (Sumberg et al., 2012:11), are reflected in everyday practices concerning the collaborative research, and expressed in the opinions of the actors participating. The various perceptions on the roles of the members and scientists by the actors involved can be seen as the 'contextual assumption' on the roles of these actors. Within Indramayu, Kees Stigter and Yunita Winarto are also part of the team of scientists, outside of their role as policymakers. The actors perceptions of their own role, and those of other actors, within the co-production of knowledge were asked as part of the interview. The answers were quite diverse, showing there was a large variety in framing of the roles within the SFS in Indramayu. Some members saw the members as the experts and the scientists learning from them about the practical side of farming, while other said that the scientists were more knowledgable and that they were distributing their knowledge to the members, in a teacher-student style relationship. Other members saw the relationship as equals, where the scientists were knowledgable in theories, while members were knowledgable in practical application of agriculture. There was thus an equal exchange in knowledge between the members and scientists. Other perspectives of the scientist's role are that they are there to help with the budget of the Klub Pengukur Curah Hujan (KPCH), as well as distribute the information outside of the club and publish the members knowledge to show the rest of the world.

This rather wide variation, and sometimes contradictory, ways of framing the roles within the collaborations, and shows that the members are all participating in the collaboration but with different perceptions on which role they have within the collaboration. This difference in perception of roles, is not in stark contrast with the scientists perceptions on the role of the members, as the members are seen as the experts in farming in their local conditions, but are seen to be in need of support from science as the impacts of climate change start to expose vulnerabilities in these farming practices. It is clear however that the scientists do not see themselves as teachers, although

Kees Stigter did agree that in the start of the collaboration there was a large top-down element in explaining various simplified theories on climate change, and in teaching the members about the principles of rainfall data collection and observations. When asked why Kees Stigter and Yunita Winarto had initiated the collaboration with the members, Mas Runa stated that he thought that Kees Stigter and Yunita Winarto wanted to collect the rainfall data to increase the knowledge about international climate conditions. Pak Kuwu Sunaryo said they wanted to make their own '*primbon*' (a book for telling the future, and also curiously, how to be a pickpocket). In other words he said they wanted to make their own forecast with the data collected. A few more members indicated they thought they were participating to gain access to the rainfall data, while others thought they were there to increase the members knowledge on the climate and pests and diseases, in order to empower the members and help them get good yields. Most of the members said they did not know what Kees Stigter and Yunita Winarto's intentions were in participating in the collaboration, as did Pak Solihin who said that inviting him was enough, as he was very happy to be part of the KPCH. Pak Condra went a step further than most in his adulation, and stated that they were a "gift from god", and that without them the members would not know anything about climate change and the impacts in Indramayu.

The manner in which the rainfall data is collected and observations are recorded, is one of the areas where there could at times be some friction between the different actors, and is taken as how the different actors frame the 'methods' within the collaborative research. Pak Kaclek had once complained about some more experienced members in his village not placing the *omplong* in the field, but near their house, which may in turn give bad examples to the new members about where they are supposed to put their new *omplong*. Kees Stigter has given the club members a set of guidelines such as the height the omplong should be placed at and how far it needs to be from any nearby buildings or trees that are higher than the *omplong*. Others are that the members need to take the measurements between 06:00-07:00 in the morning and that there needs to be a flat surface for them to make their measurements. These various guidelines are there to make the data more reliable and better to work with when analysing them in the monthly meetings and during Pak Kees's visit. Yet these guidelines are perceived and acted on in different ways. Reliability of data is a big part of good science, thus it is important for the team of scientists that the data that is being worked with is good data. Due to the novel nature of these research practices by the members, the reality looks a little different. Muki and I wrote a small report for Kees Stigter about various problems that we came across regarding the data collection by the members. Some members had placed their *omplong* near their house as going to the field every day was difficult due to busy schedules, and the roads and embankments get muddy and navigating them on a motorbike can be difficult. Some days members do not go out to the field as it is dry and there is no rain to measure, and others have been known to think after it drizzles that the number will be 0.5mm (it invariably is) and don't go out to measure it. A few use paper on their measuring sticks to make it easier to read it, yet doing this changes the number due to water absorption. These problems are a mixture of honest mistakes, and some members who are bending the guidelines slightly to fit their schedules, yet these changes would not be deemed proper scientific practices. On one side it can be perceived as wrong, and the members should rectify these mistakes. On the other hand they are introducing new practices to their schedule, practices which for scientists are a matter of commons sense, but practices that are a novelty for the members and they are trying to fit it in their daily lives. There is thus a friction on what is perceived as proper scientific 'methods' in collecting the rainfall data, which causes a dilemma as it raises questions as to how strict the guidelines should be.

The simple climate forecast is a good example on the 'forms of interpretation' of knowledge that is seen as an intrinsic part of the SFS, and how this knowledge is given 'value'. The 'forms of interpretation' manifest themselves in the perception of what 'normal' is, as it is the main concept

used within the simple climate forecast. Some of the members used the scientific definition, or a very similar one, expressing what 'normal' is numerically. Other members defined normal in a more descriptive manner, relating to more visual indicators from experiences in the field. As discussed in the previous chapter, these different ways of framing can influence both the discussion on the forecast, but also the 'value' attributed to it. The forecast is currently seen by the scientists as a tool which could potentially be used as a reference point for on-field decision making, in order to increase the possibility for adaptation to take place in light of climate change, within the goal of increasing the adaptive capacity of the club members. Mas Runa has gone as far as perceiving the usefulness of the simple climate forecast to this extent, using it as a reference point when choosing his plant varieties. Other members are currently using it as a reference point for their research, by comparing the data they collect with the forecast. There are also some members who perceive it to have no 'value' as they do not understand the forecast in its entirety, and are unable to extract any information or knowledge from it. To improve the perceived 'value' of the simple climate forecast, discussion on its contents and possible further explanation is necessary. For this discussion to have real value, the different 'forms of interpretation' that exist must be understood, in order to avoid a certain amount of confusion arising from the abstract concept of what 'normal' is. The framing of the simple climate forecast as a 'service' that has the potential to increase the adaptive capacity of the club members, frames the need to adapt to the changing climate as a "tame technical problem" (Dewulf, 2013:324). This way of framing also has bearing on how the SFS approach is presented to the wider community, as it portrays the ability of the co-production of knowledge to be able to address aspects of the impacts of climate change through making technology accessible, or creating technology tailored to fit.

Framing of the collaboration when presenting it to the wider community

During the writing of the proposal for this research prior to ever setting foot in Indonesia, I personally framed the roles of Kees Stigter and Yunita Winarto as both a scientist that is part of the SFS in Indramayu, while on the other hand being the policymaker behind the SFS approach. This perception has not changed after visiting the field, as they are both involved in the collaboration with the farmers within the KPCH, and they are constantly using this experience to adapt the conceptualisation of the SFSs. As part of her role as policymaker, Yunita Winarto spent quite a bit of time trying to find funding for the club in order to keep their activities going, but is never keen in moving away from the key principles of the collaboration. This makes it difficult to find funds, as in a talk with her she told me that NGOs are reluctant to give money, as these funds were meant to keep the club meetings going and further the learning process, which did not involve the giving of money and or technical support to the farmers (in forms of tractors, fertilisers, pesticides, etc.). The notion of keeping the collaboration on the longer term going, hinges on keeping the accounts high enough, and seemingly at this point it is moving from meeting to meeting, with the money from SAMDHANA keeping the future of the club certain, for 2013 at least. The farmer centric framing of the work done within the SFS stands in line with Dewulf's (2013) notion of "human security" (Dewulf, 2013:325), as it focusses on the benefits of the co-production of knowledge to farmers livelihoods. The long term view on the collaboration also shows that the 'technical problem' is not that 'tame', as it is seen as something that does not happen overnight, but requires a learning process that takes time.

The club members, who are portrayed to benefit from this approach, have a strong sense of identity within the club, proudly wearing specially designed t-shirts to club meetings. They do want to make it clear however that they are researchers and are not a political organisation, as red is an unlucky choice due to its association with the communist party (which has a troubled history in

Indonesia). The members also want it to be clear that anyone can join in with the clubs activities, yet they are in need of more funding and a different organisational strategy to be able to host more farmers than the current limit of 50. The club members are also still wary of spreading their information to other farmers, as they are scared of being called a 'liar' by the farmers they have shared their knowledge with, if it turns out to be 'faulty'. These ways of framing by the club members, bare significance for the policymakers in their framing of the SFS towards the wider community. As part of the conceptualisation in the recent article, Kees Stigter and Yunita Winarto (2013) sketch out the need for the extension services to be involved, albeit an improved version, in supporting the farmers, and to reach the wider community of farmers. In an interview with Kees Stigter it became clear that this would not be the case in Indramayu. Here there were plans to use farmer facilitators instead, as the farmers in the KPCH have a deep seated mistrust of the government and the extension services in Indramayu, apart from a select few of extension officers that farmers seem to get along with. In interviews with the farmers, quite a few said they wanted the government to at least acknowledge their activities. In a recent e-mail update from Yunita Winarto, it became clear that the club's activities had become acknowledged, yet involvement will always be a long shot as the farmers will only welcome them if they adhere to the clubs rules and join in the existing activities.

Hierarchy in the Indonesian culture is one thing that will stand in the way of an equal footing between the farmers and government in the collaboration within the SFSs. The farmer facilitators trained by the scientists during a recent visit by Kees Stigter, shows potential in spreading the knowledge in small circles, e.g. on village level, first. One problem with this is confidence, as some farmers have found it difficult to spread their information as they do not want to be perceived as a liar. The ineffectuality of the government's extension service and the need to improve it can be seen as framing the SFS as a way of tackling the "wicked governance problem" (Dewulf, 2013:324), while at the same time appealing to the state centric view of the need to increase food security through improving farmers ability to adapt to climate change, which is in line with de Wulf's (2013) notion of "state security" (Dewulf, 2013:325). Although it is clear the the framing of the SFSs on a policy level is one of integration with the governmental run extension services, the incompatibility between the government and the farmers in Indramayu is something to be taken into consideration when trying to implement and expand the approach elsewhere in Indonesia.

Different perceptions and the fluidity of framing

Within this chapter only a handful of "contextual assumptions, methods, forms of interpretation and values" (Sumberg et al., 2012:11) were discussed, yet is clear there is a large variation in perceptions on the different roles that both the farmers and the scientists have, as well as on the intentions of 'policymakers'. It shows that within framing it is difficult to draw an overall conclusion about how the collaboration is being framed. It does show that keeping the collaboration going with these different perceptions on the workings of the co-production of knowledge may account for varying level in participation and outcome. The different expectations individuals may have, may in the long run cause friction within the dynamics of the collaboration. One problem the co-production of knowledge is aimed at working on, a problem that has indeed been 'framed', is that climate change is an important issue the farmers and scientists have to work on. This framing is done by the majority of actors within the SFS in Indramayu. Whether or not from the farmers side this is due to learning process within the SFS or due to personal experiences, is a question that remains difficult to answer.

The SFS approach is in itself a policy, or at least part of a wider policy aimed at increasing the efficacy of the extension service in Indonesia. Comparing SFS as a policy to Dewulf's (2013) categories, it is clear that it does not fit into particular categories, as it depends on the context how it is being 'framed'. When framing the roles of the various actors within the project, it is framed more in line with the 'tame technical problem' and 'human security' frames. Discussing and promoting the SFS approach to the wider, international community, the frame changes and it is framed more in line with the 'wicked governance problem' and 'state security' frames. The contextual framing of certain facets of the SFS depending on the audience is something that one must be wary of, but can be an asset when going in search of funds or enticing collaboration partners. This contextual framing also shows that the categories of Dewulf (2013) are useful in analysing the possible frames of a policy, but does not necessarily preclude that the policy should 'fit' within a certain frame and not digress into others. The long term dynamic of the SFS also shows an interesting dynamic in the notion of framing, as it the way an actor frames a problem or indeed an action that is undertaken over a longer period of time, seems to be more fluid than static. The change in conceptualisation within the SFS approach, is an example of how the framing of how the SFS should fit in the wider, agricultural extension policy proposed by the policymakers has changed over time. It is also very possible that if I go back to interview the farmers and ask their perceptions on the collaboration, that these will have changed. On the one hand the framing of problems and activities within a project by the various actors will help shape the implementation of this project, yet the project itself will also have implications on how the various actors frame the project. In a long term collaboration such as that between the scientists and the farmers in Indramayu, this could mean a change in framing occurring due to the participatory learning process they engage in. These changes in framing have so far been minimal, but still significant enough to bare implications for the SFS in Indramayu, and for when it is implemented elsewhere in Indonesia.

Chapter 7. Discussion, Conclusions and Recommendations

As the recent review of the Science Field Shops (SFSs) discussed in Chapter 6 seems to stipulate, is that it is a central approach in creating an improved extension service in Indonesia. This improvement includes a service that is aimed at being better tailored to incorporating contextual differences and meeting farmer's needs. This research has collected and discussed data related to the practices of the participating actors, which includes both the agricultural practices of the farmers and the scientific practices of there farmers. Aspects of the practices have also been discussed as possible areas in which adaptation processes can take place. The co-production of knowledge that is central to the SFS approach has been described and the network that has resulted from this collaborative research has been elaborated on. These various practices, agricultural, scientific and learning orientated practices, will be discuss and analysed through the three principles of practice theory. These three principles are (1) "*everyday actions are consequential* in producing the structural contours of social life" (Feldman and Orlikowski, 2011:1241, highlighted as in orginial), (2) "the *rejection of dualisms* and recognition of the inherent relationship between elements that have often been treated dichotomously" (Feldman and Orlikowski, 2011:1242, highlighted as in original) and (3) "the *relationality of mutual constitution*" (Feldman and Orlikowski, 2011:1242, highlighted as in original). By analysing the practices through these lenses, this chapter aims understand the various adaptation processes that are being undertaken, and to what extent to role of the SFS approach is in these adaptations being implemented.

The final data chapter described and discussed the various frames through which the actors perceive their own role, the role of others in the SFS in Indramayu and how they frame their collaborative research to the wider community. In this chapter these findings will be revisited by analysing them through Sumberg's (2012) notion of framing, and Dewulf's (2013) categories of framing within climate change adaptation policy. This discussion will also connect these frames to the various practices within the SFS approach, and how the different ways of framing are reflected in everyday practices. This chapter will discuss the data presented in the previous chapters and analyse the various connections between the data that has been collected to see to what extent and how the various segments are connected, or indeed ,embedded within the practices. The aim is to analyse the data within the chapters, and between chapters, through the theoretical lens of practice theory and notions of framing, in order to answer the main research question: *how does the network that is created by the Science Field Shops result in adaptation of practices by the actors involved?* Conclusions from this analysis will be presented, as well as recommendations for the SFSs and further research.

Actively engaging in the collaborative research or doing the bare minimum for the stipend?

In Indramayu the SFS approach has taken its own form, in the sense that the farmers have, in discussions with the scientists, created a club (Klub Pengukur Curah Hujan (KPCH)) as a way of formalising their research activities as well as creating means to organise themselves without having to abide by government rules regarding farmers groups. To this club, the scientists are honorary members, and have their own distinct roles within the collaborative research. A rather cynical view on the participation of some of the members, would be that they were in it for the money. Then again without the monetary compensation the members would not be able to attend the meeting, which leaves it down to trust that the farmers who are members of the KPCH are adhering to the requirements of them joining: committed to collecting rainfall data and the wider

research activities. This thesis shows that most of the members are actively engaging in the co-production of knowledge, and even if money is an incentive, they are still being exposed to the research and will possibly benefit from it regardless. The request to learn how to make graphs and the initiative to run their own plant breeding workshops are good examples of this active engagement within the co-production of knowledge. A few comments by the members were that the monthly club meetings only discussing the data was in a way 'boring', and they would like to see more of such workshops. Ustad Purnama added that they would like to go on another trip outside of Indramayu, rather than only see scientists come from outside to see them. This shows an incentive to both broaden the scope of the research, as well as a sign the members want to actively broaden their network. A previous trip outside of Indramayu put them in contact with the notion of *biopori*, which is a way of increasing the soil's water retention capacity, and is now part of the programmes within the club. The use of these *biopori* was not documented in this thesis, but the potential is there.

The graph making seemed to be an important step in increasing the farmer's understanding and ability to analyse their own data. The creation of the templates shown in Chapter 5 goes from a simple page with the bare minimum to a complex graph that includes a large number of variables. In fairness such a complex graph was not the intended outcome, even though the blank template was made to give the members their own freedom in defining the contours. The resulting, complex template was for the members a success and they were getting to grips with it as even though they had created it, the ability to use it was for some still in the elementary stages. The lack of incorporation of other data than the rainfall numbers showed this. By defining knowledge, in line with practice theory, as "an ongoing social accomplishment, constituted and reconstituted in everyday practice" (Orlikowski, 2002:252, found in Feldman and Orlikowski, 2011:1243) this would indicate that the making of graphs only becomes 'knowledge' when it becomes more embedded in the learning practices of the club members. It will in turn only really increase the adaptive capacity of the members if the knowledge of making graphs becomes an asset, embedded in the farming practices of the club members. As this thesis has only discussed the dynamics of the introduction of the graphs as new knowledge, this is something future research should focus on to validate the usefulness of the graphs as a tool.

Co-production of knowledge and an emerging network

Through the lens of the first principle of practice theory, *"everyday actions are consequential in producing the structural contours of social life"* (Feldman and Orlikowski, 2011:1241, highlighted as in original), the co-production of knowledge is for both the scientists and club members becoming embedded in their day to day practices, and indeed helping shape the contours of their social lives. The introduction to the SFS approach has for both the scientists and club members broadened the social contours of their everyday lives. The club members research has added an extra activity to their daily routine, which has in turn also widened their social network to include the other club members which they meet regularly at the monthly club meetings. The monthly club meetings are central to the network, and are also central to giving meaning towards the data that is being collected as it gives a chance to discuss the implications of this data for their farming practices. The monthly meetings are also a key point in the network for scientist-member interaction, as without such a centralised meeting point the possibility of meeting each farmer every month by travelling round Indramayu would be impossible. In participating in the co-production of knowledge the scientists are expanding their practices from the basic understanding: research done to expand the knowledge on a certain topic or discipline, shared through publication of articles, books and theses. Working within the SFS in Indramayu, the scientists have four categories of

activities that are deemed part of their scientific practices. The first category is the facilitation of the members' research, the second category encompasses activities pertaining to the expansion of the learning process, the third category relates to the administrative aspects within the collaboration, and the final category is the scientists own research. By facilitating the member's research, expanding the learning process and helping with the administration, the scientists are expanding the day to day activities of their practices, while it is becoming embedded in their scientific practices as part of the collaboration with the club members. This could be seen as a very basic adaptation to the traditional role as the researcher that describes and analyses but 'does not touch'. These various additions to the 'everyday activities' of the scientists have expanded the social contours of their lives, to the extent that it has become intertwined within the social contours of the club member's social lives.

Moving on to the second principle of practice theory, "the *rejection of dualisms* and recognition of the inherent relationship between elements that have often been treated dichotomously" (Feldman and Orlikowski, 2011:1242, highlighted as in original), the knowledge generation practices that are central to the SFS cannot be seen as something removed from the main, in this case scientific and agricultural, practices of the scientists and club members. The club members agricultural practices are a key element of their research, and by doing the research they are continuously reflecting on their own agricultural practices. There is an 'inherent relationship' between their learning and their agriculture. This relationship makes identifying 'concrete adaptations' difficult as it means that knowledge gained from the learning processes of the co-production of knowledge are slowly being assimilated into the agricultural practices, indicating a slow change in practices that could be considered adaptation. Explicit adaptations such as Mas Runa's use of the seasonal climate forecast as a factor when choosing the rice varieties for the coming season, are rare. Researching adaptation posed it's difficulties as it denotes a change from one thing, to something else. To be able to document such a change, that was as a result of the learning process, was a challenge, and was attempted by asking the club members own opinion on changes they have made to their practices since joining the KPCH. Most say they had not changed anything, and others said they had diminished the use of pesticides and fertilisers, yet apart from Mas Runa, adaptations in light of climate information were not documented. This cannot however exclude the notion that adaptation processes are underway, as the inherent relationship between the learning and the on-field practices, would indicate that the knowledge being generated is in fact having some impact on the on-field practices. This has thus far been mentioned by members as a changes in fertilizer and pesticide use, with the possibility of moving to organic practices, including the use of organic fertilizer and pesticides. The fact that the members are 'thinking' and constantly reflecting on various elements of a changing climate and their own agricultural practices, through documenting these observations and graphically expressing them through graphs and maps, is in itself part of a longer term process that enables smaller adaptations in practices that may not be as explicit.

Possible reasons for the fact that there are not more explicit adaptations, become apparent when analysing the data through the third principle of practice theory, *"*the *relationality of mutual constitution"* (Feldman and Orlikowski, 2011:1242, highlighted as in original), which proposes that the agency and structure within agricultural practices cannot exist without a wide range of actors and practices. This "the total nexus of interconnected human practices" (Schatzki, 2001:11) means that the club members agency in defining their own agricultural practices is also defined by the practices of the other members, but more importantly the farmers who are not part of the club. The field preparation processes that help define when a farmer can plant his crops, are connected with wider environmental and social processes that are in part outside of the farmers agency. The access to the tractor to start the ploughing process is either defined by family ties or a centrally organised

system, while the ploughing process only starts when there is enough water in the fields to make it possible. A more pressing issue for the farmer in his the ability to decide on their own planting time, is the necessity of planting at the same time as other farmers. If the farmers plant at erratic times, then the rats and other pests can move between the fields that are maturing and attack them one by one, rather than having the impacts of these pests spread across the fields, in order to minimise the damage. During the time in the field it did not become clear as to who, and how, the timing was decided, as there seemed to be no communal effort to organise the farmers into planting at the same time. The wider network of farmers that are not part of the KPCH in Indramayu thus have a large bearing on the farmers ability to increase their adaptive capacity to climate change.

The main aim of the SFS for science is to increase the efficacy of applied research, by generating knowledge on the vulnerabilities the farmers are facing in their agricultural practices, which is partly due to climate change. So far this has been restricted to literature researches based on questions that the club members raise, and orientating research on improving the understanding the dynamics of the co-production of knowledge as well as at identifying vulnerabilities and possible adaptation strategies from carrying out research within the network of the club. Extensive field research, and indeed field or lab experiments, that have resulted directly from problems farmers raised have not yet materialised. This may be due to the majority of the students wanting to orientate their research on their own areas of interest, and due to the expertise and time of the senior scientists involved. Getting other scientists on board with a wide background in disciplines may facilitate gaining more ground in applied research in wider areas that may help increase the knowledge generated in order to facilitate the club members agricultural practices. Yet analysing the potential input from other scientists through *"*the *relationality of mutual constitution"* (Feldman and Orlikowski, 2011:1242, highlighted as in original), the activities outside of the normal role as a researcher is perhaps not an ability that all scientists can afford. Yunita Winarto and Kees Stigter both have the drive to actively want to increase sciences role in increasing the farmers adaptive capacity in climate change, and they also have the privileged position of not 'needing' to publish any more papers. 'Need' is stressed, as they still want to do so, but they do not have a quota they have to live up to in order to keep their position at a university or research institute. Such constitutional constraints may cause scientists to not want to join such a long term project, but rather look at shorter term projects that can prove more fruitful in producing publications. They are indeed embedded in a system that facilitates them doing research, but does not necessarily facilitate long-term commitments to facilitating, and increasing the learning process of farmers.

Seasonal climate forecast as a 'tool'

One of the long-term commitments that is part of the SFS in Indramayu, is the creation and spreading of a seasonal climate forecast, which gets a monthly update. Each forecast explains in a short text message the likely scenario for the coming three months. The spreading of the seasonal climate forecast is still being worked on in a practical sense, as there are still some club members who are not getting the text message. A deeper issue lies in the fact that there is a difference in understanding of what the forecast means, and what the purpose of the information is. The club members either have a numerical understanding on what 'normal' is, which invariably is very close to the scientific definition for the region, or they have a very descriptive understanding of what 'normal' is, which invariably refers to regular rainfall events where there is not too much rain (causing floods) or too little rain (causing drought). Along with this different understanding of the terminology used within the season climate forecast, there is a difference in how they find it useful. A majority of the club members asked used their own rainfall data and compare it with the seasonal climate forecast. In this case they are testing it's accuracy based on the data they are collecting and

'know to be true' in order to see how much they can 'trust' the seasonal climate forecast they get from Kees Stigter. There are only two cases that highlight the use of the seasonal climate forecast as a tool to influence decision making. The first is of Pak Haji Sarma, who was deciding whether or not to plant in the dry season based on the forecast where drought was expected. Due to visible signs of rains and a drive to grow paddy, Pak Haji Sarma ignored the advice and planted, and it turned out to be the wrong decision. The second case is of Mas Runa, who uses the seasonal climate forecast as a tool when deciding which rice variety to plant. With wetter than normal weather, Mas Runa opts for more robust varieties as a way of dealing with flooding, while with drier than normal weather, he would opt to choose shorter term varieties, better at withstanding drought. These are two different examples highlighting the possible usefulness of the forecasts. The first is whether or not to plant at all (drastic measure) and the second is where the decision making process can be aided. Mas Runa has fitted the simple climate forecast into his farming practices, yet he is currently an anomaly where most of the club members use the forecast as a reference point for their research, but not necessarily for their farming practices.

The seasonal climate forecast has thus a way to go before it is integrated into the farming practices of the club members. This is however not a critique on how the SFS in Indramayu is treating the use of the seasonal climate forecast, it is more highlighting that viewing the seasonal climate forecast as a tool to be used to inform decision making practices, it could currently quite quickly be discarded. Yet looking at the longer term and committing to a "sustained interaction" (Roncoli, 2006:93), the seasonal climate forecast can become a reference point that becomes embedded in the farming practices of the club members. Understanding the members understanding of, and perception on, the seasonal forecast requires a longer term interaction between the provider (in this case Kees Stigter) and the recipient (in this case the club members) in order to understand how they perceive the seasonal climate forecast (Roncoli, 2006). The divergence in understanding of 'normal' that exists within the club members, and in part, between the members and the scientists, illustrates this. This divergence does not necessarily have to be negative. Taking knowledge as "an ongoing social accomplishment, constituted and reconstituted in everyday practice" (Orlikowski, 2002:252, found in Feldman and Orlikowski, 2011:1243), it is no wonder that the scientists and club members have diverging ideas about what 'normal' is. Everyday practices of scientists and farmers are different, and the farmers have a more sensory way (observing and feeling) of perceiving the environment and thus their definition of normal is more descriptive than the scientists', who invariably perceive the environment through a model based on numbers. Along with Kees Stigter's delineation of how he perceives a 'service', discussing the forecasts is when it becomes a service. Understanding how the actors participating are defining the concepts, such as 'normal', in the forecasts is essential for the discussion on it's content. It does not necessary mean the various actors need to have the same definition, they just need to have an understanding of how the other is perceiving the information or advice. In short: the way the actors frame the knowledge.

Extending the network: the importance of framing

The variety of understanding and perception of the forecast as something useful, shows that there are different 'forms of interpretation' of the 'knowledge' provided by the seasonal climate forecast, as that there are different 'values' given to this particular service. The need for a "sustained interaction" (Roncoli, 2006:93) in order to increase the understanding, and increase the usefulness of the seasonal climate forecast, has in part to deal with the different frames through which the actors perceive the forecast. This ties in closely with Sumberg's notion of framing, which he defines as "the particular contextual assumptions, methods, forms of interpretation and values that different

groups bring to a problem" (Sumberg et al., 2012:11). It is also through the 'contextual assumptions' of the roles of the actors within the SFS, and the ways in which the various actors perceive the 'methods' through which the members collect their data that differences in framing come to the fore. Rather than blindly assume that the various actors perceive the roles of the members and scientists as conceptualised, there is a need to keep up to date with the various ways in which the actors frame the roles. This is due to the fact that various assumptions about the others role can be in conflict with what the other actor thinks their own role is, and that of the other actors. In order for collaboration to be working efficiently, there needs to be at least an understanding about how each actor perceives the other, and the work they are doing. This becomes more apparent in the 'methods' the members use to collect their data, as they invariably bend Kees Stigter's guidelines to be able to fit the research into their daily lives. This lessens the analytical value from a scientific perspective, but then the question remains how strict the guidelines should be, as if they were to be very strict with them then possibly more members would not be able to carry out their research. Thus a trade off is made with data reliability and the ability to do the research in the first place. The various frames need to be understood, in order to be able to move past such possible frictions, and in order to move the collaboration forward in a way that all the actors are happy with.

Expanding the network both on the side of the scientists and the farmers, and more importantly spreading the knowledge being generated in the co-production of knowledge in the SFS, is a way of addressing the wider community constraints to implementing adaptation practices. This is however the point where the SFS approach is still struggling with. The conceptualisation, and indeed the framing, of the SFS approach is constantly being adapted to try and address these issues. The SFS is proposed as part of an improved, more well informed, extension service in Indonesia. The problem for the club members in Indramayu is indeed exactly that: the existing 'extension service'. There is a mistrust of this government run service that makes working with them and the farmers together nearly impossible, which leaves the question as to how the knowledge is going to be spread to other farmers. The idea proposed at the moment is the training of farmer facilitators within the club, both to help the club members with their research, but also to spread the knowledge they have with farmers in their neighbourhood. A problem with this is that many club members have expressed that they are wary of spreading their knowledge, as they do not want to be called a 'liar' if the knowledge they have spread turns out to be inaccurate (especially with regards to the forecast). Thus neither through the government run service, or through farmers, is currently working too well, yet given the time to gain trust in their own knowledge there is a change the spreading of the knowledge through a network of farmers may prove to be fruitful.

The framing of ones own role, the role of the actors in the SFS and indeed the role of the potential actors, are important in understanding the potential dynamics in the expansion of the network. The scientists have had to take a step back from their idea to use the extension network as a way of reaching the wider farming community, because the club members negatively frame the possible role of the extension officers in the club. A main issue was that the club members were happy to work with the government, but only if the government wanted to work with the club on a level playing field, and to an extent following the club's rules. Including the fact that Indonesia has a hierarchical society, this seems highly unlikely, and thus a collaboration between the government and the KPCH seems unlikely. The question then remains if this conclusion, which is likely contextual, has any implications for the further implications for the implementation of the SFS approach in other areas in Indonesia. Understanding whether or not the government is looked at as negatively as with most of the club members in Indramayu, is something that needs to be researched and understood before, or during, the implementation of the SFS. If the government is out of favour in the new area, then an alternative, such as the farmer facilitators, should be identified. Another more drastic measure would be that the government ran a campaign to try and increase the image of

the extension service in portraying it as something the farmers may find a useful source of knowledge and support, which they can give more substance through the proposed SFS approach.

The framing of the SFS approach to the wider community, may provide insights into why the farmers are hesitant about collaborating with the government in Indonesia. When portraying the problem members face in a changing climate within the project, it is often seen "as a tame technical problem" (Dewulf, 2013:324) and "as an issue of […] human security" (Dewulf, 2013:325), while when portraying it to the wider community, the problem is more often framed as "a wicked governance problem" (Dewulf, 2013:324) and "as an issue of state security" (Dewulf, 2013:325). It is exactly at the point where the discussion revolves around the 'human security' versus 'state security', where the members will have doubts about the involvement with the government. The government may see the famers ability to produce food in a larger context, such as food security in the cities, than the farmer does, whose main priority is to provide enough food and income for his family. For the policymakers the move towards framing the policy in line with the 'state security' frame, is made to be able to appeal to the government because they know that the government thinks on a larger scale than the individual or community of farmers. This is the point were the policy should tread carefully, in order not to lose the 'human security' frame that typifies the implementation of the SFS, when writing up the policy documents that will dictate how the SFS will be implemented in other part of Indonesia. Looking at the implementation of the SFS in Indramayu, it becomes clear that the problem of climate change adaptation is not only seen "as a tame technical problem" (Dewulf, 2013:324), but also in certain aspects as a "a wicked governance problem" (Dewulf, 2013:324). The bureaucracy that is synonymous with the irrigation system is an example of such a 'wicked governance problem' and the ability to make use of available water more efficiently is an example of a 'tame technical problem'. The delineations made within Dewulf's (2013) categories are not mutually exclusive, and do not necessarily need to be seen dichotomously. They do however provide a good mode of analysis in understanding how a policy is perceiving a problem, and how it aims to help 'solve' the problem.

Framing must also not be seen as a static entity, as peoples perceptions and understanding of something can change over time. The changes made to the conceptualisation of the SFS approach by moving away from traditional, linear teaching to the farmers, is an example of this. The current focus on the collection of rainfall data and observations, and the perceived importance of this, may shift slightly to increasing the importance of incorporating various new strategies into the farming practices. The findings in this thesis, and the understanding of framing within this thesis, may have to be revisited once the co-production of knowledge has been running for a substantial period of time. A likely scenario would be that the focus and the framing of the problems have shifted, maybe even completely away from the impacts of climate change on the agricultural practices. Explicit discussions about the roles the farmers and scientists have within the collaboration may be good at clearing up doubts and understanding where each of the actors stand, how they want to proceed with the collaboration and which other actors they may want to see getting involved in the collaborative effort. Such a discussion may be difficult to facilitate, as getting the nuances of ones own frame is difficult enough, let alone understand how another actor may be framing the same thing.

Technography and Mechanisms

This theses has looked at adaptation through processes and concrete adaptation practices, an from a more short-term, adaptation perspective, the conclusion would have to be that there are only a few practices such as Mas Runa's use of the seasonal climate forecast would be seen as concrete adaptation. In a more long-term, knowledge assimilation perspective, there are more signs that the

adaptation processes of the members are occurring and that adaptation strategies that emerge from the co-production of knowledge may be implemented. Through this perspective it is early days yet. Various social and environmental factors that could hinder the implementation of adaptation strategies were discussed, and the main mechanism that facilitates the planting strategy in terms of timing was the need to plant at the same time as other farmers. This both bears its importance as a means of reducing pest and disease impacts, yet the lack of social organisation of such an important part of the farming practices is something this thesis was not able to understand. Access to water was a more environmental mechanism, that both proved to be vital in the planning of the planting process, yet proved a factor that would also play a part throughout the season as it could result in drought or floods that are detrimental to crop success. The ability to cope with drought and floods can both be seen as planning (planting appropriate crops) and as performance (responses to flooding by finding ways to transplant from other parts of the field, or buying stock from other farmers). The seasonal climate forecast is already proving beneficial for members such as Mas Runa, and the continued access to the information and discussions about the significance of the forecasts, will prove to be a key mechanisms in realising its potential to be a reference point for decision making within the agricultural practices of the club members. It becomes clear when trying to identify mechanisms in relation to practices that they change depending on which question is asked and the focus of the (potential) adaptation.

The mechanisms that facilitate the co-production of knowledge and the network that has materialised through the SFS in Indramayu, are clearly the monthly meetings, coupled with the members and scientists own research. The monthly meeting is the central space for interaction between the various actors, and gives a space to discuss the findings of the research, as well as a form of social control with regards to doing the 'homework'. Outside of these meetings the contact is mainly between members within their respective villages, while text messages are shared across distance between members and scientists. These messages invariably state rainfall data numbers, and are both a way of sharing ones experiences, but also (indirectly) checking up on other members to see if they are doing their research properly. The willingness to learn is a key requirement to being part of the KPCH. The final mechanism that underpins the network of club members in Indramayu, is the organising of the members through a club rather than a group, as it gives them both geographical and regulatory freedom in comparison with a government registered farmers group. The mechanisms that facilitate the scientists involvement in the club, is the willingness to perform tasks such as expanding the farmer knowledge and administrative work that lie outside of the scientists basic practices. This may take time away, and focus away, from other initiatives that may provide scientific publications that are invariably part of job requirements. Extending the network within the scientific community may also be a struggle, like the extension of the network within the farming community. The framing of the roles of the actors and their relative agency is a key mechanism in order for collaboration to take place with institutions such the extension service.

Conclusions

This thesis has covered a wide range of aspects of the SFS approach, and how it has been implemented in Indramayu. The organisation of the farmers in a club, and the organisation of monthly club meetings has facilitated participation in the co-production of knowledge, and also proves to be a central space for the network that has emerged within the SFS in Indramayu. Expanding the network outside of the SFS is proving difficult both on the farmers side, as well as the scientists side. This will prove instrumental as it will both facilitate more learning and access to more adaptation strategies, as well as accessing the wider farming community will facilitate adaptation strategies that need communal effort. Framing of the roles of the various (potential)

actors may hinder in extending the network, but if discussed properly they may provide beneficial in identifying possible ways of increasing the reach of the knowledge generated in the SFS. The perception and understanding of the climate forecast must be understood in order to facilitate the discussion on the forecast, as well as improving its potential in providing a reference point for agricultural practices. Although there have been limited adaptations to practices of the actors involved within the SFS, there is a potential that the adaptation processes will become more apparent once the various actors start embedding the knowledge gained within the co-production of knowledge in their practices.

Climate Change Adaptation: the importance of researching practices.

This thesis has aimed to contribute to what Smit and Wandel (2006) have coined as the "practical application" (Smit and Wandel, 2006:285) field of research concerning itself with climate change adaptation. 'Practical application' refers here to an understanding of the vulnerabilities farmers, and other actors, face in light of climate change in order to identify adaptations that will fit into the local context (Smit and Wandel, 2006). Through understanding the dynamics of a long-term, climate change adaptation project in action, an extra dimension is added to Smit and Wandel's (2006) notion of 'practical application'. In order for the vulnerabilities to be identified, and for adaptation processes to be facilitated, a long-term, sustained interaction must take place. This has been advocated by Roncoli (2006) in improving the usefulness of climate forecasts, and also has bearing on the adoption of other adaptation processes. Even though in a short period of time the SFS in Indramayu has identified various vulnerabilities farmers are facing, and various adaptation possibilities have been identified, yet there is still a lack of adaptation practices being implemented. There is a need for the various actors to adjust to the notion of adopting novel ideas into their practices, as well as the fact that their practices are embedded in the wider community that may need to collaborate in implementing the same adaptation, in order for the adaptation to be realised. The decision making processes within these practices are not only made up of pre-seasonal planning, but are constantly made throughout the season, and are seen as 'performance' (Crane et al., 2011). This strengthens a need for this 'sustained interaction', as adaptations can occur throughout the season, as a reflection of this 'performance', in light of stresses of climate variability.

There is also a need to look at adaptation processes in terms of practices, as the ability to implement theoretically suitable adaptive strategies is embedded in the wider network of practices. The 'rejection of dualisms' within practice theory implies that the climate is already an integral part of the farmers agricultural practices, as are other aspects of their social lives such as the fluctuating economy, which is reflected in Smit and Wandel (2006) notion of 'mainstreaming' which notes that "it is extremely unlikely for any type of adaptive action to be taken in light of climate change alone" (Smit and Wandel, 2006:285). This is however where the limitations of this thesis come to the fore, as it was not able to look at the influences of the different scales and other sectors that have an implication on, or one could go as far to say embedded in, the adaptation processes at the level of practices (Adger et al., 2005; Smit and Wandel, 2006). Adaptation processes are reflected in practices, which are embedded in a wider, multi-scalar, context, and are constantly being enacted throughout the season through the notion of performance. There is thus a need for sustained collaboration on multiple scales, in order for climate change adaptation processes to occur within practices. The SFS approach is part of a broader concept aimed at improving the extension service in Indonesia to provide such a collaborative effort between policymakers, scientists and farmers. The SFS approach is thus also coming close to addressing the need for science "to play an important, partial role in instigating adaptation actions that go beyond the ongoing, experience-based response process" (Meinke et al., 2009:69).

References

Adger, W.N., Arnell, N.W., Tompkins, E.L. (2005) Successful adaptation to climate change across scales. *Global Environmental Change* **15**, 77-86.

Alexander, L., Allen, S., Bindoff, N.L., Bréon, F.-M., Church, J., Cubash, U., Emori, S., Forster, P., Frieldingstein, P., Gillett, N., Gregory, J., Harmann, D., Jansen, E., Kirtman, B., Knutti, R., Kanikicharla, K.K., Lemke, P., Martozke, J., Masson-Delmotte, V., Meehl, G., Mokhov, I., Piao, S., Plattner, G.-K., Dahe, Q., Ramaswamy, V., Randall, D., Rhein, M., Rojas, M., Sabine, C., Shindell, D., Stocker, T.F., Talley, L., Vaughan, D., Xie, S.-P., (2013) Summary for Policymakers, in: Intergovernmental Panel on Climate Change (IPCC) (Ed.), *Working Group I Contribution to the IPCC Fifth Assessment Report: Climate Change 2013: The Physical Science Basis*. IPCC, Geneva, Switzerland, pp. 1-36.

Binternagel, N.B., Juhrbandt, J., Koch, S., Purnomo, M., Schwarze, S., Barkmann, J., Faust, H., (2010) Adaptation to climate change in Indonesia-livelihood strategies of rural households in the face of ENSO related droughts, in: Tscharntke, T., Leuschner, C., Veldkamp, E., Faust, H., Guhardja, E., Arifuddin, B. (Eds.), *Tropical Rainforests and Agroforests under Global Change*. Springer Berlin Heidelberg, Berlin, Deutschland, pp. 351-375.

Crane, T.A. (2010) Of models and meanings: Cultural resilience in socio-ecological systems. *Ecology and Society* **15**, 19.

Crane, T.A., Roncoli, C., Hoogenboom, G. (2011) Adaptation to climate change and climate variability: The importance of understanding agriculture as performance. *Njas-Wageningen Journal of Life Sciences* **57**, 179-185.

Dewulf, A. (2013) Contrasting frames in policy debates on climate change adaptation. *Wiley Interdisciplinary Reviews: Climate Change* **4**, 321-330.

Encyclopedia Britannica (2013) Java. Encyclopedia Britannica, Chicago, USA. Retrieved 20/11/2013, from http://www.britannica.com/EBchecked/topic/301673/Java.

Feldman, M.S., Orlikowski, W.J. (2011) Theorizing practice and practicing theory. *Organization Science* **22**, 1240-1253.

Freie Universität Berlin (2013) Alpine hazards in times of climate change: Patterns of interpretation and strategies of action from the 18th to the 21st century. Freie Universität Berlin, Berlin, Deutschland. *Retrieved 20/11/2013*, from http://www.polsoz.fu-berlin.de/en/ethnologie/forschung/arbeitsstellen/Umweltanthropologie/forschung/Alpine_Naturgefahren_im_Klimawandel/index.html.

Gerring, J. (2007) The Mechanismic Worldview: Thinking Inside the Box. British Journal of Political Science 38, 161-179.

INSAM (2013) The International Society for Agricultural Meteorology. *Retrieved 20/11/2013*, from http://www.agrometeorology.org/about-insam/society-information.

Jansen, K., Vellema, S. (2011) What is technography? *Njas-Wageningen Journal of Life Sciences* **57**, 169-177.

Kurasawa, A. (2007) Forced Delivery Of Paddy And Peasant Uprisings In Indramayu, Indonesia - Japanese Occupation and Social Change. *The Developing Economies* **21**, 52-72.

Lynch, A., Tryhorn, L., Abramson, R. (2008) Working at the boundary - Facilitating interdisciplinarity in climate change adaptation research. *Bulletin of the American Meteorological Society* **89**, 169.

Meinke, H., Howden, S.M., Struik, P.C., Nelson, R., Rodriguez, D., Chapman, S.C. (2009) Adaptation science for agriculture and natural resource management — urgency and theoretical basis. *Current Opinion in Environmental Sustainability* **1**, 69-76.

Nelson, D.R., Adger, W.N., Brown, K. (2007) Adaptation to Environmental Change: Contributions of a Resilience Framework. *Annual Review of Environment and Resources* **32**, 395-419.

Orlikowski, W.J. (2002) Knowing in practice: Enacting a collective capability in distributed organizing. *Organization Science* **13**, 249–273.

Orlove, B., Roncoli, C., Kabugo, M., Majugu, A. (2010) Indigenous climate knowledge in southern Uganda: the multiple components of a dynamic regional system. *Climatic Change* **100**, 243-265.

Philippine Rice Research Institute, (2011) Climate Change and Rice Production, Questions and Answers. *Philippine Rice Research Institute, Nueva Ecija, The Philippines.*

Richards, P., (1989) Agriculture as Performance, in: Chambers, R., Pacey, A., Ann, T.L. (Eds.), *Farmers First: Farmer Innovation and Agricultural Research.* Intermediate Technology Publications, London, United Kingdom, pp. 39-43.

Roncoli, C. (2006) Ethnographic and participatory approaches to research on farmers' responses to climate predictions. *Climate Research* **33**, 81-99.

Roncoli, C., Crane, T., Orlove, B., (2009) Fielding climate change in cultural anthropology, in: Crate, S.A., Nuttall, M. (Eds.), *Anthropology and climate change. From encounters to actions.* Left Coast Press, California, USA, pp. 87-115.

Roncoli, C., Ingram, K., Kirshen, P. (2002) Reading the rains: Local knowledge and rainfall forecasting in Burkina Faso. *Society & Natural Resources* **15**, 409-427.

Sari, A.P., Sari, R.E., Butarbutar, R.N., Maulidya, M., Rusmantoro, W., (2007) Indonesia and Climate Change: Current Status and Policies. *Peace, DFID and The World Bank, Jakarta, Indonesia*.

Sayer, A., (2000) Chapter 1 - Key Features of critical realism in practice: a brief outline, in: Sayer, A. (Ed.), *Realism and social science*. Sage, London, pp. 10-28.

Schatzki, T.R., (2001) Introduction: practice theory, in: Schatzki, T.R., Cetina, K.D.K., Von Savigny, E. (Eds.), *The Practice Turn in Contemporary Theory.* Routledge, London, United Kingdom, pp. 10-23.

Schipper, E.L.F. (2006) Conceptual History of Adaptation in the UNFCCC Process. *Review of European Community & International Environmental Law* **15**, 82-92.

Siregar, P.R., (2010) Do farmers use climate forecast information to respond to climate variability? - Technographic studies on impact of Climate Field School in year 2003 on crop management strategy of farmers in Indramayu District, Indonesia, in: Richards, P., Crane, T. (Eds.), *MSc Thesis*. Wageningen University & Research Centre, Wageningen, pp. 1-101.

Siregar, P.R., Crane, T.A. (2011) Climate Information and Agricultural Practice in Adaptation to Climate Variability: The Case of Climate Field Schools in Indramayu, Indonesia. *Culture, Agriculture, Food and Environment* **33**, 55-69.

Smit, B., Wandel, J. (2006) Adaptation, adaptive capacity and vulnerability. *Global Environmental Change* **16**, 282-292.

Stage, J. (2010) Economic valuation of climate change adaptation in developing countries. *Annals of the New York Academy of Sciences* **1185**, 150-163.

Stigter, C.K.J., Winarto, Y.T. (2013) Science Field Shops in Indonesia - A start of Improved Agricultural Extension that Fits a Rural Response to Climate Change. *Journal of Agricultural Science and Applications* **2**, 112-123.

Sumberg, J., Thompson, J., Woodhouse, P., (2012) Contested Agronomy: Agriculture research in a changing world, in: Sumberg, J., Thompson, J. (Eds.), *Contested Agronomy: Agriculture research in a changing world*, First edition. Routledge, Abingdon, Oxon, pp. 1-21.

Thornton, P.K., Jones, P.G., Alagarswamy, G., Andresen, J., Herrero, M. (2010) Adapting to climate change: Agricultural system and household impacts in East Africa. *Agricultural Systems* **103**, 73-82.

Winarto, Y., Stigter, K., Anantasari, E. (2008) Climate Field Schools in Indonesia: Improving “response farming" to climate change. *Leisa Magazine,* ileia, Amersfoort, pp. 16-18.

Winarto, Y.T., Stigter, K. (2011) *Agrometeorological Learning: Coping Better with Climate Change.* LAP LAMBERT Academic Publishing, Deutschland.

Winarto, Y.T., Stigter, K., Anantasari, E., Prahara, H., Kristyanto, (2010) 'We'll continue with our observations' - Agro-meteorological learning in Indonesia. *Farming Matters - Small-scale agriculture for a sustainable society.* ileia, Amersfoort, pp. 12-15.