Chapter 8

Practising Anthropology by Providing Climate Services for Farmers

The Case of Science Field Shops in Indonesia

Yunita T. Winarto

During the period in which I began my engagement facilitating farmers in a dry, rain-fed ecosystem in Yogyakarta Province in Java, Indonesia, in the early rainy season of 2008, rains fell continuously for seven days in a row. The farmers interpreted this as an indication that it was time to begin their rainy-season cultivation. However, after the initial deluge, not a single drop of rain fell for three full weeks. In the farmers' terms, this long dry spell was known as *benthatan*. Unexpectedly, two days of heavy rains followed the long dry spell, and the rice and maize, which had only recently been planted and had grown slowly during the dry period, were damaged due to the heavy rains and flooding. Farmers questioned these sudden heavy rains following the long dry spell (Winarto et al. 2011:188–89). Six years later, in 2014, at the time I began introducing methods of agrometeorological learning to the farmers of another dry, rain-fed village in Western Nusa Tenggara Province, an elderly farmer's interpretation of the fall of intensive rains based on local cosmology led farmers to expect plentiful rains at the beginning of the rainy season in around November. However, his prediction proved incorrect and the farmers experienced an extended drought. Every year, in February, the villagers of this area traditionally hold a ritual for 'catching up sea-worms' (the ritual of *Bau Nyalé*). This festival usually occurs at a time of heavy rains. However, in February 2015, the weather was surprisingly dry (Taqiuddin 2017) and the people could not explain why it was so.

These are but a few examples of the increasing occurrence of unexpected weather phenomena in local habitats that have aroused puzzlement among farmers in Indonesia. Their expectations about weather events, informed by generations of traditional knowledge, have been upended beyond their ability to understand and to foresee. They did not at first realize that the unusual conditions were the result of climate change.

The experience of these farmers is not unique. Farmers all over the world have reported changes in both rain patterns and the timing of rainy seasons (Jennings and Magrath 2009), and local traditional knowledge – though empirically rich and detailed – often constrain people from understanding and explaining the drivers of hazards and disasters that are beyond their ability to predict and understand. The consequences of climate change include global warming, increasing climate variability, and more frequent and severe weather events that affect people's livelihoods, particularly in vulnerable areas such as tropical Asia. Increases in temperatures, along with shifts in seasonal patterns, may have grave consequences for human health, as well as for agricultural and ecosystem productivity (Winarto et al. 2018b). These effects will worsen with time.

Over the past decade, a growing number of anthropologists have conducted detailed ethnographic fieldwork among widespread local communities so as to examine the various problems deriving from, and people's diverse knowledge of and strategies to cope up with, climate change (Barnes and Dove 2015; Colombi 2009; Crate 2009, 2011; Crate and Nuttall 2009; Ellis 2003; Finan 2003, 2009; Henshaw 2009; Marino and Schweitzer 2009; Nuttall 2009, 2010, 2012; Roncoli, Crane and Orlove 2009; Roncoli et al. 2003; Strauss 2003, 2009; Strauss and Orlove 2003). These anthropologists are trying to glean 'the effects of climate variability and change on human societies, cultural perceptions, the connections of global and local processes, and the contribution of human actions to Green House Gas concentrations' (Fiske et al. 2014: 15). As suggested by the Global Climate Change Task Force of the American Anthropological Association (Fiske et al. 2014), anthropologists need to play a more significant role in climate science and policy by engaging in collaboration with other disciplines in both the social and natural sciences. The increasingly significant contributions of anthropologists include research in much wider areas, so as to connect diverse scales, places and paths; addressing various issues related to adaptation, vulnerability and resilience; and developing research frontiers by also enhancing their engagement with local communities.

My own experiences in building up interdisciplinary and transdisciplinary collaboration in assisting farmers in Indonesia have led me to agree strongly with the proposal that anthropologists should play a more significant role in climate science and policy. In light of the degree of vulnerability that local communities have to overcome in dealing with the implications of the unusual risks arising from increasing climate variability, I argue for greater anthropological engagement with local communities in a manner that extends beyond simple ethnography or the implementation of a participatory approach (Roncoli 2006). Examples of such an engagement include the collaborative and interdisciplinary research undertaken by Button and Peterson (2009), and Crate and Fedorov (2013) in directly facilitating local communities to cope with the consequences of climate change through the exchange of local and scientific knowledge.

By considering the prognosis of continuous and ongoing climate changes and their probable consequences, which are likely to be increasingly variable, I question the extent to which such limited exchanges are sufficient to assist people in sustaining their adaptive responses over the long term. For example, Crate and Fedorov's (2013) interdisciplinary project involved eight knowledge-exchange sessions. Would an additional cycle of knowledge exchange be provided in the future if the people were to face entirely different kinds of hazard and calamity? Similarly, Button and Peterson (2009) returned to observe the results of their participatory work after a relatively short period of time. It is unclear if the problem-resolution strategies introduced to local communities could be sustained if the scientists were no longer available to provide assistance. Would the local people and other stakeholders be able to resolve further hazards and disasters in the future by referring to their experience of receiving the scientists' help in the past? Whilst anthropologists have often built up intimate relationships on an ongoing basis over lengthy periods with the people they have studied (see Crate (2009, 2011) and Crate and Fedorov (2013) with regard to the Viliui Sakha in northeastern Siberia, or Nuttall (2009, 2010, 2012) with regard to the Inuit), the need to build up long-term, sustainable community collaborations involving scientists from various disciplines presents a new challenge.

My experience of observing a short-duration training project implemented by the Indonesian state and several nonprofit organizations has convinced me that a lack of commitment to the continuous education of local farmers has hindered the institutionalization of new knowledge due to the absence of nurture for their learning through continuous reflection and reiteration (see Winarto et al. 2018a). As an anthropologist, I have learned how farmers can interpret new knowledge, and modify, accommodate and combine it with other existing elements, so that it becomes the basis of action or, alternatively, and particularly in the absence of institutional support, how the knowledge may become forgotten without being recalled again (Winarto 2004). During this period of dynamic and ongoing climate change, it is important both to follow and build on traditional learning processes, and to enhance them by establishing new, sustainable ways of learning. The state's one season-long training without any follow-up activities as carried out in the Climate Field School (CFS) proved to be ineffective in institutionalizing the new learning in farmers' responses to increasing climate variability and its unexpected consequences (Crane and Siregar 2011). A mutual and enduring learning situation may provide a means for establishing the new understanding of climate variability over time that could have diverse impacts on farmers' ecosystems and farm productivity. Responsive farming practices need to be developed under the unprecedented changes of climate. The long-term educational commitment is thus urgent in order to address later questions concerning the ongoing puzzling problems that will arise. The role of anthropologists is critical in enabling new scientific methods and knowledge, such as agrometeorology, to be transmitted to local communities in such a manner that they also improve farmers' ways of learning and enrich their existing knowledge, becoming internalized as a part of their learning and doing.

This chapter examines the development of a novel process of practising anthropology, with innovative interdisciplinary and transdisciplinary collaboration in the provision of climate services to farmers in Indonesia via Science Fields Shops (SFS), an educational programme of agrometeorological learning (Winarto and Stigter 2013, 2016, 2017; Winarto, Stigter and Wicaksono 2017). The first section of this chapter presents the SFS approach, with a focus on its underlying purpose of providing seven climate services to farmers in two regencies: Indramayu Regency on the north coast of West Java Province, and East Lombok Regency on the east coast of Lombok Island in the Province of West Nusa Tenggara. The second section examines the novel contribution of anthropologists in their engagement with both the agrometeorologists and the farmers in establishing and institutionalizing the SFS over time. The final section presents a reflection on anthropologists' role as creative agents in the provision of climate services.

Science Field Shops in Indonesia: Providing Climate Services to Farmers

Indonesia is located along the equator in the tropical monsoon region and has two major growing seasons: the rainy season and the dry season. Smallholding farmers in Indonesia conventionally replicated their traditional planting strategies and the introduced Green Revolution intensification technologies in each growing season.[1] However, the consequences of climate change have confused farmers, as they must now face unusual risks and/or opportunities that are not in line with their conventional cropping strategies. Thus, providing climate services to farmers in order to improve their anticipation of, and capability to respond to, these consequences is an urgent need (Winarto et al. 2018b). A significant shift in farmers' mindsets and practices – which have been formed over the past five decades of the Green Revolution paradigm – is necessary in order to enable them to develop more flexible decision-making processes to address climate-related changes in future growing seasons. Accordingly, the main focus of the SFS is to improve the farmers' ways of learning.

Seven climate services have been established as the primary means of learning agrometeorology. The services involve the exchange of knowledge, both new and scientific and traditional and empirical, between scientists and farmers, farmers and farmers, and farmers and extension intermediaries (if available) (Stigter and Winarto 2015; Winarto et al. 2018b). These activities are aimed at improving farmers' knowledge and understanding of the recent past and present conditions of their fields, and they are positioned as active learners, researchers and analysts of their own discoveries.

Figure 8.1. A farmer measuring rainfall (photograph by Aria S. Handoko, the Science Field Shops-Universitas Indonesia, 2015)

Guidance on daily rainfall measurement and agroecosystem observation constitute the first and second SFS climate services. By carrying out daily rainfall measurements and agroecosystem observations on their own fields, farmers are expected to learn: (a) the methods and procedures of measuring rainfall and the practice of daily agroecological observation; (b) the rainfall data revealed by those measurements; (c) the variability of rainfall across different stations (places) and times; (d) the impact of particular rainfall patterns on their fields and plants; and (e) the detailed conditions of their agroecosystem.[2]

Monthly meetings are held between farmers, scientists and (where available) extension intermediaries to discuss the farmers' data, their fields' vulnerabilities, and ways to resolve problems. The role of farmers as researchers and the dialogic approach taken in the regular meetings are the most important elements that distinguish SFS practice from other learning methods such as extension meetings and single-season training of the CFS (Crane and Siregar 2011).

The third SFS climate service involves measuring seasonal yields and identifying explanations for differences in measurements, observations, inputs (amounts and timing) availability, affordability and use. At the end of each planting season, scientists help the farmers to make yield

Figure 8.2. Farmers discussing their rainfall and agroecosystem data at a monthly meeting (photograph by Yunita T. Winarto, the Science Field Shops-Universitas Indonesia, 2017)

comparisons between their different fields, and intrafield comparisons between the same seasons of different years and between different seasons in the same year. Farmers perceive this exercise as beneficial because they are able to evaluate and learn probable causal factors related to differences in agricultural yields, and it is expected that based on these evaluations, farmers will be empowered to improve their strategies under similar/different climate conditions in the future.

Smallholding farmers invited to join the SFS operate their farms either as owners or operators. Those who are willing to join and do not own land are asked to mount their rain gauges in other farmers' fields with their permission and involvement in the learning process. To empower them within this transdisciplinary learning programme, farmers are invited to organize the SFS activities on their own, and the fourth climate service entails assisting them in managing these SFS programmes. It is important to help farmers to prepare for the ongoing and dynamic phenomena of climate change, which have created uncertainties in terms of what to expect from the weather and climate in the near and distant future.

The scientific input of the agrometeorologist in providing updated seasonal climate predictions in the form of seasonal rainfall scenarios based on the satellite data of the El Niño Southern Oscillation for the forthcoming three-month period, adjusted to their seasonal monsoon climate, is the most significant element of the fifth SFS climate service. This allows the agrometeorologist's own scientific development of considering the predictions of gradual rainfall reduction and more serious heatwaves to be harnessed for the farmers' use. For farmers, these scenarios have been very helpful in helping them to predict future climate conditions and to incorporate these scenarios into their anticipation and decision-making strategies. For example, a group of rainfall observers in a village in Indramayu provided their suggestions to their fellows to avoid planting watermelon in the second dry season of 2017 due to their understanding of the probable disastrous impacts of La Niňa as predicted in the seasonal scenarios they received. Their decisions to halt planting watermelon saved them from any bankruptcy, unlike their fellows who did not follow their advice.

The sixth service provided by the SFS is the delivery of new knowledge and answering farmers' queries regarding the agricultural/climatological problems they face throughout the year. Providing answers to such questions is an ongoing policy of the SFS and will continue even when the scientists withdraw and the out-scaling of the SFS has been settled.

Farmers are always curious and creative in the trial-and-error-practices they develop to solve immediate problems and to increase their agricultural yields, and the seventh SFS service aims to introduce new ideas and experiments that will supply answers to urgent local questions. Such experiments include new testing strategies that should help reduce methane emissions by improving water and biomass management, select suitable rice varieties under particular climate conditions, determine proper fertilizer and pesticide application methods, ascertain appropriate planting distances between rice hills, and identify the degree of soil homogeneity in farmers' fields (Stigter 2016; Walker 2017).

In summarizing his experience with the SFS, one farmer-facilitator declared that 'the advantages were enormous'. Specific success stories include the avoidance of harvest failure, the gain of additional yields, the sustaining of yields in the midst of ongoing hazards, and learning from mistakes that have led to yield reduction and harvest failure (Taqiuddin 2017; Winarto, Stigter and Ariefiansyah 2017; Winarto et al. 2018b). In addition to the benefits to farmers, the anthropologists have advanced their own knowledge of climate-related issues in farming and agrometeorological analyses, as well as their facilitation skills, by teaming up with the agrometoerologists in bringing the applied dimensions of agrometeorology to Indonesian farmers.

Anthropological Engagement in Establishing Agrometeorological Learning

During his visit to Indramayu in 2013, the first agrometeorologist involved in the SFS, Kees Stigter, who used to work in some African countries and China argued that in delivering the agrometeorological science to farmers, extension intermediaries are necessary. As an agrometeorologist, he did not have the training to deliver the products of applied agrometeorology directly to farmers. Thus, in his visit to Indramayu in 2013, he confessed that he would not have been able to deliver the applied science to the Indonesian farmers without the anthropologists' assistance: 'In my visits to African countries, I used to work with extension workers and not with farmers. This is the first time in my life that I can assist the farmers directly with your guidance and help' (Stigter, personal communication, May 2013). Stigter's remark highlights the critical role of anthropologists in bridging the gap between scientists and local communities.

Even without any training and experience in agrometeorology, simply by 'being there' (Roncoli, Crane and Orlove 2009), and being humble enough to learn, as well as by having an understanding of farmers' learning and knowledge (Winarto 2004, 2011), we had the confidence to accept the agrometeorologist's initiatives and assist Stigter's efforts. The origins of this transdisciplinary collaboration date to the end of 2007, when Stigter was visiting Gunungkidul, following the termination of a CFS held in a hamlet.[3] Stigter learned of farmers' puzzlement regarding the new problems they were experiencing in the face of climate change and offered his help if the farmers would be willing to commit to adhering to his innovative approaches, and the farmers agreed. However, based on the challenge of presenting concepts grounded in Western science to local village farmers, it was determined that Stigter would require aid in sustaining his educational initiatives. Thus, the anthropologists' journey began with the role of 'facilitator' to the farmers. While immersing themselves into farmers' daily life, the anthropologists helped the farmers better understand the agrometeorological observation method and the ways of documenting their data. In doing so, the anthropologists had to translate the scientific terms into the farmers' own vocabularies so as to enable them grasping the new meaning easily. Assisting farmers in practising the new methods of observation, documentation and evaluation became part of their roles. By understanding farmers' problems and constraints in mastering the new scientific ideas, the anthropologists were able to communicate those constraints to the agrometeorologist so as to inform him of any problems found in the field. By doing this work, the anthropologists gradually assumed the role not only of facilitator and translator, but also of collaborator and mediator to both of them. Mediating the two domains of knowledge – the scientific and the local – had been part of the anthropologists' significant work.

In Winarto and Stigter (2013: 425–26), we summed up the three main roles of the anthropologists as: (1) the main organizers of the SFS;[4] (2) facilitators working closely with farmers in managing and assisting them; and (3) ethnographers observing, documenting and interpreting the entire sequence of events. The latter was possible due to the presence of students conducting their ethnographic fieldwork by accompanying farmers to the fields and observing their activities while assisting them if necessary. Throughout the students' and the anthropologists' immersion in farmers' daily lives, an ongoing reflection of the progresses as well as the obstacles the farmers' experience were able to be documented. Such a close relationship provides an opportunity for a continuous learning by both sides through ongoing reflection and intersubjectivity. However, participation as engaged anthropologists in climate science and applied agrometeorology was an evolving process and, as such, it involved a number of challenges to be resolved over time. Despite the initial successes of the SFS, we determined that we needed to become even further engaged with these communities on a long-term and collaborative basis.

Being Creative Cultural Translators, Mediators and Facilitators

Being translators, mediators and facilitators, as advocated by Fiske et al. (2014), was not as simple and easy as we had expected, as the scientist and the farmers had each developed their own ways of knowing, based on different premises, concepts and methods. Even though I had a general understanding of how both domains of knowledge worked, agrometeorological science was relatively new to me, and in the early years of accompanying farmers, it was a demanding job to identify the appropriate simple Indonesian terms for abstract agrometeorological concepts such as 'air convection', 'evaporation', 'transpiration', 'atmosphere', 'El-Niño/La-Niña', 'solar radiation', 'orographic rain', etc. Literal translations were often inadequate in conveying the underlying concepts upon which the terms were based, and I had to learn how to transform the abstract concepts into concrete descriptions and visualizations informed by what farmers knew and did not know. I ultimately succeeded in this task by learning from the references related to climate change and by being creative in finding effective strategies for communication, such as drawing on a piece of paper, using concrete examples and repeating the same word several times when explaining a term in simple Indonesian, so that the farmers gradually grasped the new meaning.

A similar problem, with a higher degree of difficulty, was the translation into Indonesian of the meteorological terms in the monthly seasonal climate scenarios, which were sent in English by the agrometeorologist. As the anthropologist, I had to circulate the translated version via mobile phone to farmers to help them determine their immediate actions, if necessary. Selecting the Indonesian words for technical terms such as 'near normal', 'above normal' and 'below normal' was a significant challenge. As in the above case, I learned to understand the farmers' interpretation of a 'normal' rainfall pattern as it related to their daily lives and farming activities. Gradually, through repetition during each monthly meeting and numerous informal visits and discussions, farmers developed an understanding of the range of 'normal', as well as the 'above normal' and 'below normal' in each month based on rainfall data collected in each field. The farmers' own common sense of those ranges of rainfall based on daily experience was gradually replaced by precise quantitative data. The process was easier for the farmers who had collected more than five years of rainfall data. Led by Kees Stigter and later on by his substitute, Sue Walker, and by Ariefiansyah from our SFS team, they could identify the ranges of 'normal', 'above normal' and 'below normal' monthly rainfall by developing the probability rainfall graphs based on their own data. Therefore, the shorter the duration of learning, the more difficult it was for the farmers to grasp novel terms and concepts. Only by engaging in continuous interaction with the farmers and following their observations and discussions over time could I grasp their interpretations and misinterpretations of new terms and concepts learned in the SFS.

A similar approach was also useful in developing my role as a 'mediator' between the two domains of knowledge. From the beginning, I understood that the 'rules' of operationalizing the SFS was in the agrometeorologist's hands. Thus, adhering strictly to the methods and rules he had established for measuring rainfall and observing the agroecosystem was a must. However, because the agrometeorologist did not spend extensive time in the field, he could not convey the details of how to lead farmers in documenting the data. The incremental improvement of the monthly data sheets filled in by the farmers and of the contents of their log books are examples of how the anthropologists developed innovative ideas to help the farmers focus sharply and precisely on what needed to be documented. The anthropologists further processed the data sheets, transferring them into a digital spreadsheet so as to enable the agrometeorologist to read, interpret and analyse the farmers' data in order to follow what was going on in their fields and habitats, and to determine what needed to be done in order to improve the farmers' understanding (Prahara, Winarto and Kristiyanto 2011; Winarto and Stigter 2016). The determination of the new knowledge and methods for the agrometeorologist to deliver in the SFS was also influenced by listening to the anthropologists recount their observations. Though he complained of the farmers' sloppiness in data documentation in the early years, the agrometeorologist gradually came to understand our explanations of the difficulties the farmers had in inscribing and documenting the complex phenomena they encountered in their fields and habitats. The shift from complex spoken descriptions of related components of agroecosystem and rainfall data to simple written texts with numbers and fewer words represented an enormous change in the farmers' ways of expressing and analysing.

Though farmers were able to improve their data-collection skills, we had to accept the reality of their inability to document their observation as completely as the scientists preferred, meaning that 'garbage in and garbage out', as the agrometeorologists complained, was often inevitable (Winarto and Stigter 2016). The farmers' consciousness of the importance of having proper documentation increased as they understood the significance of being able to 'tie their knowledge into the book so as not to "fly" away', in the words of one elderly farmer. Another agreed that: 'I would like to make my own *pranata mangsa* [the Javanese agricultural calendar] for my children and grandchildren to refer to in the future.'

Some farmers requested that we convert the manual data and rainfall graphs created from our collaboration into a digital system, and we eventually developed a means of digitization. In addition to digital monthly and annual rainfall graphs, following the introduction of a probability graph of rainfall data in the 2016–17 'training of trainers' by Sue Walker (who replaced the late Kees Stigter),[5] the farmers and the anthropologists began collaborating to produce probability graphs to define the range of 'near normal', 'above normal' and 'below normal' for each farmer's dataset. This co-creation of rainfall graphs represents evidence of the incremental development and evolving changes experienced by both the scientists and the farmers.

Without positioning ourselves as the farmers' friends and companions, as well as programme facilitators, and without our creativity in identifying any and every possible means of improving our co-creation of knowledge, I would strongly argue that sustaining and developing the SFS would have been impossible.

Establishing and Institutionalizing a New Tradition of Learning

The early stages of the institutionalization of a new tradition of learning involved changes to the way in which the farmers recorded their empirical observations in writing, and marked a significant difference between the approaches of the SFS and the CFS. As a farmer who had joined a CFS prior to his participation in the SFS observed, the former did not involve the systematic production of a dataset by individual farmers over a long time period, whereas in the SFS, each participant gradually built up a sense of ownership over the data they had personally collected over months and years from the same rainfall station.

However, going to the field every morning to observe their fields and measure rainfall at the same hour was a new 'habit' that the farmers had to develop, and obtaining their cooperation and adherence to established procedures proved to be challenging. As Stigter advised, based on the increasing uncertainties the farmers would face in the future, 'measuring rainfall should be part of your habit, like drinking a cup of water or coffee every morning'. Not all farmers were happy to do such work and develop this new 'habit' in the absence of the financial rewards as offered by other state-sponsored projects, and withdrawal from participation in the SFS was common during its early stages. As observers and outsiders, we could not force the farmers to continue to participate. We also observed that number of members of the group/club fell in cases when the SFS had been formed by a local agricultural official who had made a decision about who should join.

Those who decided to continue as members of the rainfall observers group learned that rainfall data could not be acquired without their enthusiastic and persistent willingness, effort and motivation. With the agrometeorologist's guidance and the anthropologists' facilitation, correction and explanation of the nitty-gritty of mounting a rain gauge and measuring and documenting the data, the farmers gradually internalized the rules for practising the new skills they had learned.

To address the initial difficulties in identifying the rainfall station of each farmer when they reported the data, the anthropologist introduced the idea of assigning a code to each rainfall station, for example, BUKL01 (BU = *Barat Utara* or northwest zone; KL = Karang Layung, the name of the village; 01 = number in the list of all rainfall stations in one regency). Though the farmers only referred to these codes when making their written and oral reports for the monthly evaluations, over time they came to embody an 'identity' for each rainfall station and also indirectly identified their associated farmers/rainfall observers. Over the years, a kind of 'belonging' gradually linked the farmers with their rainfall stations and the associated datasets they were collecting.

Another challenge hindering data collection was the farmers' tendency to move the rain gauge to the yards of their houses during busy times of field activities (e.g. ploughing, harvesting) or in the fallow period. Upon learning of this practice from our field observation reports, the agrometeorologist prohibited it, declaring that the resulting rainfall measurements would be worthless. Though it was not easy to establish the rule, the farmers were ultimately able to understand our explanation of why it was not acceptable to remove the rain gauges, and together we developed a compromise whereby shifting the rain gauge around during busy times in the field was allowed, but bringing it home was not. An additional challenge arose when one farmer decided to move his rain gauge to another field permanently, without changing the code of the rainfall station. After discovering this and processing the resulting dataset, I realized that it would not be possible to have the same code for the different rainfall stations because of the diverse ecosystems distinguishing the two fields, but I needed to devise a means of expressing this in a manner that would convince the farmers. I explained that the farmers' own rainfall data showed variations even among different fields located near each other. If a farmer were to present the data collected from two different fields as a single bundle of data rather than as two different datasets, then it would not accurately represent the conditions of one rainfall station. After listening to this, the farmer who had moved the rain gauge to another field agreed to change the code for his new rainfall station so as to distinguish it from the earlier station code of BUKL01.

Following on the numbering of the existing rainfall stations, his new rainfall station was assigned the code of BUKL43. From this point on, he only reported the data from the new rainfall station. After this incident, I began to announce the rule and repeat its explanation when introducing the SFS to new groups of farmers in different locales.

The above are examples of rules developed over time based on our experiences in the field. Once they were internalized by the farmers, the same procedures were introduced to new members and new clubs/groups. By observing practices that were incongruent with the rules as set up by the agrometeorologist and by discovering the farmers' modifications and innovative decisions taken in response to the existing circumstances, the anthropologists had opportunities to learn and develop their responses. Through similar processes during various other activities, such as agroecosystem observation and documentation, yield evaluation and farmer-field experiments, the institutionalization of new forms of knowledge was gradually established.

Enriching Knowledge and Stimulating Changes to Crop Farming

Since the early 1990s, my examinations have shown me that farmers are diligent observers of their own fields and practices (Winarto 2004). *Ilmu titèn* (memorable detailed science) is the term used by farmers in Yogyakarta to refer to the thorough knowledge they have developed of their own fields and habitats. Taxonomies of soil texture-type-colour and types of rainfall are examples of such knowledge (Kristiyanto and Winarto 2011). However, farmers' interpretation of everyday phenomena they encountered is based on their accumulative experience and subjective understanding. Without any objective knowledge received from external agents such as scientists and extension intermediaries, farmers rely on their own interpretation of the efficacy of their own strategies as they were accustomed to do in the past. Example was their habit to apply recommended balanced chemical fertilizers as introduced in the Green Revolution package. Relying on their interpretation that applying the recommended fertilizers' components improved crop productivity, they did not understand the impacts of the excessive use of nitrogen on the growth of plants and the probable disease infestation. Rice blast infestation on rice has been increased in the past decade along with the increased rainfall intensity and humidity in the rainy season. Climate variability was beyond their imagination and they had no understanding of its drivers.

Gradually, for rainfall observers, the new elements introduced in the SFS became part of an 'interconnected pattern of interpretive elements

[that] can be activated by minimal inputs' (D'Andrade 1992: 29; see also Strauss and Quinn 1997). Once farmers understood the meanings, as well as the function and benefits, of the newly introduced elements, they could be integrated into the existing interconnected systems of crop farming and, incrementally, a new interconnected pattern of interpretive elements was developed. For example, numeric rainfall data provided them with an additional element to be interpreted in combination with other elements of their knowledge of field agroecosystem and plant growth. The data collected from diverse rainfall stations located throughout the regency allowed farmers to realize how varied the rainfalls actually were in the region, and this discovery supported the agrometeorologist's insistence that rainfall should be measured separately at each rainfall station, with its unique ecosystem. When the farmers noted that the same rainfall measurement in two different fields resulted in differing impacts on the soil and amounts of water trapped in the field, they recognized the causal factors underlying those differences while interpreting their connection with another element, namely, the varied soil texture. The longer they conducted the rainfall measurements and the more the dataset expanded, the more new elements to their own observations and the richer the understanding they gained of the relationships between rainfall patterns, humidity, variations in the maturation ages of particular plant varieties, and the impact of pests and diseases.

Based on his thoughtful examination of the relationship between rainfall patterns in different seasons and pest and disease problems, one farmer was able to draw his own annual graph modelling those components. By drawing two graphs − the rainfall and the growth of pest population or the intensity of disease − for rainy season and dry season planting separately, he was able to conclude that pest population would be higher in the dry season than in the rainy season. On the contrary, the occurrence of diseases would be higher in the rainy season than in the dry season. These graphs were simple and easy to understand. Feeling satisfied of his discovery, the farmer told his fellows in the regular monthly meeting and others in his neighbourhood to anticipate the probable pest outbreak in the dry season and the disease infestation in the rainy season.

The overuse of chemical pesticides was another element discussed quite frequently in relation to pests and diseases. The connections between rainfall, humidity, pests and diseases, and farmers' treatments were strengthened through repeated discussions during the monthly evaluation meetings, and some young farmers were motivated to try to reduce the quantity and frequency of pesticide application. They discovered that this produced the same (or even much higher) yields, while resulting in less damage, by comparison with fields that had been sprayed excessively. Their evidence strengthened the connection between those elements and led to persistent changes in their pest management practices. It was our regular discussions that were the driver of this change. As one farmer informed us: 'Because you always raised the question in the monthly meeting as to why we kept spraying *obat* ['medicines', a local term for pesticides], I was curious to discover whether or not reducing the spraying would cause damage to my crops.' Simply by being there, listening to farmers' reports and discussions, raising some questions and providing explanations if necessary, the anthropologists' presence and queries served as an effective means to induce a significant change in local practice, without any efforts at imposition or enforcement. We simply raised questions regarding the farmers' strategies every time we had the chance to observe and/or to discuss their agrometeorological analyses. A rainfall observer told me how he changed his behaviour regarding the spraying pesticides after receiving our repeated questions as to why he had to spray the plants. Farmers also modified their strategies of sowing seeds in the nursery, after learning from one another's effective strategies under the delay of the rainy season planting or at the beginning of a dry season.

The dissemination of monthly seasonal climate scenarios was another novel element introduced by the SFS. As argued by Roncoli et al.: 'Recollections of the past, observation of the present, and expectation for the future shape our experience of climate phenomena and our understanding of climate information' (2003: 181). Prior to joining the SFS, the custom was to implement a repetitive cultivation strategy each planting season, without any consideration of probable 'abnormal climate conditions'. By developing an outlook of future climate scenarios, in combination with patterns gleaned from recent and long-term experiences in detailed observations of rainfall and their fields' agroecosystem, the farmers were able to anticipate probable risks and/or opportunities. Farmers' ability to foresee future climate conditions grew on the basis of an understanding of the seasonal scenarios, and of the interconnections between their past and recent experiences. The strategies that were most effective could thus be defined, due to the farmers' improved anticipation capability (Nuttall 2010), and their standpoints were strengthened based on the evidence they gained from being successful in harvesting or, alternatively, experiencing harvest failures. Being responsive to the probable forthcoming climate scenarios became perceived as a correct and sensible path.

Improving their confidence as to the effective strategy in particular climate conditions also motivated the farmers' resistance towards certain government policies, once they understood their probable maladaptive consequences. For example, based on the forthcoming La Niña, during the dry-season period of 2017, the Ministry of Agriculture defined a policy for farmers on the north coast of West Java of continuously planting rice in fields usually left fallow, or those planted with other secondary crops following the dry-season planting. However, a group of rainfall observers in a village in the middle of Indramayu Regency had gained experience and knowledge from SFS participation, and they knew the great risks to their fields and yields posed by the increased and severe pest and disease problems associated with continuous planting. These farmers strongly voiced their reluctance to plant rice three times a year and, unlike those who dared not do otherwise, those who stuck to their decision not to follow the government's policy were saved from total harvest failure. Unfortunately, in the next growing season, severe, regionwide pests and diseases outbreaks resulted in harvest failure even for those who had limited their planting to two periods. As one rainfall observer lamented: 'I planted paddy five times, but I did not harvest anything.'

Though the farmers' reluctance to plant rice three times in a row did not yield any significant change in the central state's policy, a collective strategy made at the village level could have produced more resilient rice cultivation. However, this was successful only when, upon the village leader's invitation, a group of rainfall observers at a village in Indramayu Regency was able to provide their anticipative strategy at a village meeting. Based on a climate scenario foreseeing the forthcoming El Niño in 2014/15 as associated with a possible late start to the rainy season and a short duration of rainfall, the rainfall observers assisted the village leader in determining a planting schedule and the choice of rice variety of short maturing age that would reduce the risk of harvest failure from the early cessation of rains. This strategy was combined with the result of observing the peak flight of white-rice stem-borer moths in the beginning of the season. By referring to the pest's life cycle and the period of moonlight, the farmers and the village leader determined the planting schedule so as to avoid the time of high population of white-rice stem-borer moths during a full moon at the primordia stage of rice plants. Therefore, the strategy was also aimed at avoiding crop damage due to the outbreaks of white-rice stem-borer moth infestations. Whilst farmers in other areas on the north coast of Indramayu kept planting rice without any additional irrigation and experienced severe harvest failures, farmers in that village could harvest their yields (Winarto, Stigter and Ariefiansyah 2017). Thus, whereas the other rainfall observer, who kept planting rice, bitterly lamented his inability to engender a collective decision, in the absence of a warning system or planting alternatives provided by the authorities, later rainfall observers had pride and confidence in their own anticipative and responsive strategies.

Another significant change to the farmers' cultivation schema and practices occurred with the adoption of scientific premises in conducting agricultural field experiments. Farmers had previously performed trial-and-error experiments to test whatever strategies they intended to implement in a plot over a single period of time, and it was common to provide different treatments to address several variables at once. This practice was implemented by a number of rainfall observers conducting the new farmer-field-experiments we had introduced in 2013. The latter was called the 'win-win solution'. Rather than carrying out systematic experiments involving the modification of a single variable among different plots of land, a number of rainfall observers had implemented various types of treatments in their experimental plots simultaneously. Fortunately, after being corrected by the agrometeorologist and receiving further explanation and reiteration from the anthropologists, the farmers grew to understand the logic of, and the procedure for, carrying out experiments based on scientific premises, and they obeyed those rules in later experiments. Whereas previously one farmer might modify up to four variables (crop variety, planting distance, water management and soil tillage) in a single field, they ultimately learned to test only one variable at a time, which would be altered in different plots while the other variables remained constant. The farmers agreed that they obtained better results when conducting experiments using this method.

All of the above examples demonstrate the gradual and incremental changes in farmers' cultivation schema and practices produced through ongoing interaction between, and reflection by, the knowledge provider (the agrometeorologist), the facilitators (the anthropologists), and the recipients (the farmers). Through continuous dialogue and mutual respect and commitment, the scientists were able both to build upon and extend the farmers' ecological and scientific knowledge and practices, thus providing them with tools to adapt and respond to current and future challenges deriving from the increasing climate variability.

Towards Future Anthropological Practice in Climate Services: A Reflection

Anthropologists' engagement in the SFS is an example of their potentially significant role in climate science and policy on the basis of interdisciplinary collaboration with scientists from other disciplines, and of engagement with local communities or other stakeholders. This kind of collaborative work aligns well with the knowledge-exchange practices advocated by other researchers (e.g. Barnes and Dove 2015; Crate 2011; Fiske et al. 2014); however, such projects are demanding in terms of time, effort, financial support and the need to think creatively in the face of emerging and unexpected problems. Any anthropologist willing to engage in such exchanges must be prepared to dedicate his or her time and passion in persistently carrying out the work on a continual and ongoing basis.

In comparison with other state-sponsored programmes delivered over short-term periods, as well as such time-limited programmes of developing knowledge exchange as previously implemented by Button and Peterson (2009), and Crate and Fedorov (2013), the implementation of continual study by anthropologists through establishing learning institutions such as the SFS could be more beneficial in advancing local people's learning of scientific premises and rules (I emphasize the term 'learning' instead of 'knowledge' per se). Achieving this aim depends on the anthropologists' work in materializing the applicable dimension of agrometeorological knowledge on the ground, in their roles as cultural translators and mediators between other scientists and farmers, and as facilitators for farmers. This kind of work not only improves the farmers' scientific-learning process, but also enhances the ways in which agrometeorological knowledge is implemented within local domains of learning. Such a significant role should be sustained and improved upon by anthropologists in any future collaborative work related to climate issues. Yet, as Lassiter (2008) argued, this kind of work requires particular methods of training in order to advance and improve young anthropologists' knowledge, skills, and passion, to enable them to engage in a more collaborative form of ethnography. Continual training has to be established for the new generation of scholars to move them beyond being merely cultural translators and instead involve them in the work of community engagement.

My experiences have increased my confidence that such collaborations do not lead to ethical violations if they do not jeopardize farmers' livelihoods or cause other trouble for them, and do aid them in reducing their vulnerabilities and improving their resilience in the face of unusual risks. However, without the consent and agreement of a local community in building up the collaboration, anthropologists should not enforce their intended aims, and when facing farmers' queries, they should remain humble in consulting the appropriate experts. For future advancement, anthropologists looking to assist local communities in addressing climate change should build networks involving experts in diverse disciplines depending on the nature of the varying risks, hazards and/or vulnerabilities to which the farmers have to respond.

However, even such an ongoing form of engagement has its time limits, and an exit strategy should be defined that considers the financial support and time allocations available. Within the available timespan, anthropologists should work with the farmers to design a means of preparing them to be able to disseminate their new learning and to facilitate their fellows being rainfall observers once the scientists have departed. Among the seven climate services provided in the SFS, the scientists could only continue their participation in two over the long term: the dissemination of seasonal climate scenarios and the provision of new knowledge based on farmers' own needs and requests. The other services have to be continued by farmers individually and as groups. Thus, more structured training needs to be provided for farmer-facilitators and extension workers (if available) to improve their knowledge and skills relating to climate, weather and agrometeorological issues, as well as to strengthen their confidence as able facilitators for other farmers.

Carrying out advocacy among policy-makers is an even more demanding and challenging task. Based on my experience in introducing and promoting the SFS as an effective educational commitment, and in involving policy-makers to support the programme in their regions, additional strategies have to be considered in implementing such inclusion efforts. Despite the fact that the SFS could not be operationalized without the involvement of anthropologists, our expertise regarding climate and weather issues was questioned, relative to that of the scientists involved in meteorology-climatology-agrometeorology. Policy-makers accustomed to designing technologically driven, project-based, short-term programmes with a top-down approach will be reluctant to develop any longitudinal educational commitment such as the SFS, and changing this perspective will not be easy. A thorough understanding of the regional bureaucratic culture, administrative systems and programmatic approaches needs to be the basis for advocacy to policy-makers, and further study is necessary to address such challenges in the future.

Yunita T. Winarto is Professor of Anthropology at the Faculty of Social and Political Sciences, at Universitas Indonesia (yunita.winarto@gmail.com). She is also Academy Professor Indonesia (for Social Sciences and Humanities) under the auspices of the Royal Netherlands Academy of Arts and Sciences and the Indonesian Academy of Sciences, and has been a member of the Cultural Commission of the Indonesian Academy of Sciences since 2013. She received her Master of Science in Environmental Technology from Imperial College, London and a Ph.D. in Anthropology from the Australian National University, Canberra. Her research is focused on the dialectics of local and scientific knowledge in farmers'

cultivation and livelihood, integrated pest management, plant breeding, and farmers' response to climate change. She has published *Seeds of Knowledge: The Beginning of Integrated Pest Management in Java.* (Yale Southeast Asia Studies, 2004).

Notes

1. The Green Revolution was introduced in Indonesia in the early 1970s to increase agricultural production.
2. The agroecosystem observation and documentation is of the commodities, ecosystem, soil types, land management, sowing methods, total monthly rainfall, rainfall impact on fields, planting schedule, water management, growth conditions, fertilizers, pests and diseases and their control strategies, natural enemies and root depth. These were collected on large data sheets and in the farmers' own log books.
3. Climate Field School (CFS) is an Indonesian state's one-season-long training for farmers and was developed on the basis of the methods of the Integrated Pest Management Farmer Field School (IPM FFS) introduced in the early 1990s. Once in every ten-day period, the facilitators provided resources on various subjects related to climate, weather and their implication for farmers' fields and crops. The training on measuring rainfall and observing agroecosystems was carried out in the designated plot for observation, not on individual farmers' fields. Farmers were positioned as the CFS participants and not as researchers of their own fields. No further facilitation was carried out by the CFS in the period after training (Anantasari, Winarto and Stigter 2011; Boer 2009; Crane and Siregar 2011).
4. Throughout the course of our work, until the time we decided to 'exit' from Indramayu and East Lombok Regencies in early 2018, our team, which was under the responsibility of the Center for Anthropological Studies, Faculty of Social and Political Sciences, University of Indonesia, was not successful in obtaining financial support from the regencies' governments' annual budgets. We had to find donors from other institutions, from within the country and abroad, to enable us to pursue our collaborative work. However, in planning our 'exit' from the field, we assisted the farmer rainfall observers to organize their own group with the expectation that they would not only be able to arrange the SFS activities on their own, but would also be able to generate financial support from various sources. In early 2018, we finally managed to obtain agreements and commitments from the regencies' governments to incorporate the SFS into their five-year development plans and budgets.
5. Professor Kees (Cornelis Johan) Stigter was a visiting professor at the Faculty of Social and Political Sciences at the University of Indonesia (2011–16). He initiated the SFS from 2008, but passed away in May 2016 in Jakarta after visiting Indramayu to deliver the training of trainers for farmer facilitators and attending the monthly regular meeting. Professor Sue Walker, an agrometeorologist from the University of the Free State, South Africa and the African Agricultural Research Council, replaced the late Professor Stigter from November 2016.

References

Anantasari, E., Y.T. Winarto and K. Stigter. 2011. 'Climate Field School: Learning and Understanding Some Scientific Knowledge of Climate', in Y.T. Winarto and K. Stigter (eds), *Agrometeorological Learning: Coping Better with Climate Change*. Saarbrucken: LAP LAMBERT Academic Publishing, pp. 44–85.

Barnes, J., and M.R. Dove (eds). 2015. *Climate Cultures: Anthropological Perspectives on Climate Change*. New Haven: Yale University Press.

Boer, R. 2009. 'Sekolah Lapang Iklim Antisipasi Risiko Perubahan Iklim [Climate Field School Anticipating the Risks of Climate Change]', *Salam* 26: 8–10.

Button, G.V., and K. Peterson. 2009. 'Participatory Action Research: Community Partnership with Social and Physical Sciences', in S.A. Crate and M. Nuttall (eds), *Anthropology and Climate Change: From Encounters to Actions.* Walnut Creek, CA: Left Coast Press, pp. 327–40.

Colombi, B.J. 2009. 'Salmon Nation: Climate Change and Tribal Sovereignty', in S.A. Crate and M. Nuttall (eds), *Anthropology and Climate Change: From Encounters to Actions.* Walnut Creek, CA: Left Coast Press, pp. 186–96.

Crane, T., and R.P. Siregar. 2011. 'Climate Information and Agricultural Practice in Adaptation to Climate Variability: The Case of Climate Field Schools in Indramayu', *Culture, Agriculture, Food and Environment* 3(2): 55–60.

Crate, S.A. 2009. 'Gone the Bull of Winter? Contemplating Climate Change's Cultural Implications in Northeastern Siberia, Russia', in S.A. Crate and M. Nuttall (eds), *Anthropology and Climate Change: From Encounters to Actions.* Walnut Creek, CA: Left Coast Press, pp. 139–52.

———. 2011. 'Climate and Culture: Anthropology in the Era of Contemporary Climate Change', *Annual Review of Anthropology* 40: 175–94.

Crate, S.A., and A.N. Fedorov. 2013. 'A Methodological Model for Exchanging Local and Scientific Climate Change Knowledge in Northeastern Siberia', *Arctic* 66(3): 338–50.

Crate, S.A., and M. Nuttall (eds). 2009. *Anthropology and Climate Change: From Encounters to Actions.* Walnut Creek, CA: Left Coast Press.

D'Andrade, R. 1992. 'Schemas and Motivation', in R. D'Andrade and C. Strauss (eds), *Human Motivation and Cultural Models.* Cambridge: Cambridge University Press, pp. 23–44.

Ellis, D.M. 2003. 'Changing Earth and Sky: Movement, Environmental Variability, and Responses to El Niño in the Pio-Tura Region of Papua', in S. Strauss and B. Orlove (eds), *Weather, Climate, Culture*. Oxford: Berg, pp. 161–80.

Finan, T.J. 2003. 'Climate Science and the Policy of Drought Mitigation in Ceará, Northeast Brazil', in S. Strauss and B. Orlove (eds), *Weather, Climate, Culture*. Oxford: Berg, pp. 203–16.

———. 2009. 'Storm Warnings: The Role of Anthropology in Adapting to Sea-Level Rise in Southwestern Bangladesh', in S.A. Crate and M. Nuttall (eds), *Anthropology and Climate Change: From Encounters to Actions.* Walnut Creek, CA: Left Coast Press, pp. 175–85.

Fiske, S.J. et al. 2014. *Changing the Atmosphere: Anthropology and Climate Change* (Final Report of the AAA Global Climate Change Task Force). Arlington, VA: American Anthropological Association.

Henshaw, A. 2009. 'Sea Ice: The Sociocultural Dimension of a Melting Environment in the Arctic', in S.A. Crate and M. Nuttall (eds), *Anthropology and Climate Change: From Encounters to Actions.* Walnut Creek, CA: Left Coast Press, pp. 153–65.

Jennings, S., and J. Magrath. 2009. 'What Happened to the Seasons?' OXFAM Research Report, October. Retrieved 12 March 2021 from https://www.oxfam.org.au/wp-content/uploads/2012/02/OAus-WhatHappenedToSeasons-0110.pdf.

Kristiyanto and Y.T. Winarto. 2011. 'Farming in a Dry Rainfed Ecosystem', in Y.T. Winarto and K. Stigter (eds), *Agrometeorological Learning: Coping Better with Climate Change*. Saarbrucken: LAP LAMBERT Academic Publishing, pp. 25–43.

Lassiter, L.E. 2008. 'Moving Past Public Anthropology and Doing Collaborative Anthropology', *NAPA Bulletin* 29: 70–86.

Marino, E., and P. Schweitzer. 2009. 'Talking and Not: Talking about Climate Change in Northwestern Alaska', in S.A. Crate and M. Nuttall (eds), *Anthropology and Climate Change: From Encounters to Actions.* Walnut Creek, CA: Left Coast Press, pp. 209–17.

Nuttall, M. 2009. 'Living in a World of Movement: Human Resilience to Environmental Instability in Greenland', in S.A. Crate and M. Nuttall (eds), *Anthropology and Climate Change: From Encounters to Actions.* Walnut Creek, CA: Left Coast Press, pp. 292–310.

———. 2010. 'Anticipation, Climate Change, and Movement in Greenland', Études/Inuit/Studies 34(1): 21–37.

———. 2012. 'Tipping Points and the Human World: Living with Change and Thinking of the Future', *AMBIO* 41: 96–105.

Prahara, H., Y.T. Winarto and Kristiyanto. 2011. 'The Joint Production of Knowledge: Its Dynamics', in Y.T. Winarto and K. Stigter (eds), *Agrometeorological Learning: Coping Better with Climate Change*. Saarbrucken: LAP LAMBERT Academic Publishing, pp. 145–80.

Roncoli, C. 2006. 'Ethnographic and Participatory Approaches to Research on Farmers' Responses to Climate Predictions', *Climate Research* 33: 81–99.

Roncoli, C., T. Crane and B. Orlove. 2009. 'Fielding Climate Change in Cultural Anthropology', in S.A. Crate and M. Nuttall (eds), *Anthropology and Climate Change: From Encounters to Actions.* Walnut Creek, CA: Left Coast Press, pp. 87–115.

Roncoli, C. et al. 2003. 'Meteorological Meanings: Farmers' Interpretations of Seasonal Rainfall Forecasts in Burkina Faso', in S. Strauss and B. Orlove (eds), *Weather, Climate, Culture*. Oxford: Berg, pp. 181–200.

Stigter, K., and Y.T. Winarto. 2015. 'Agrometeorological Learning: Exchanges of Traditional, More Recent Empirical and Scientific Knowledge between Farmers, Extension Intermediaries and Scientists', *International Workshop on Environmental Education in Indonesia, Depok, 5 December 2015*. Depok: Universitas Indonesia.

Stigter, K. (C.J.). 2016. 'Science Field Shops with Farmer Extension Intermediaries for Climate Services in Agriculture', Training of Trainers (ToT) Roving Seminar Training Guidance, Selong and Indramayu, March–April 2016.

Bruchem and Depok: Agromet Vision and the Center for Anthropological Studies, Faculty of Social and Political Sciences, Universitas Indonesia.
Strauss, S. 2003. 'Weather Wise: Speaking Folklore to Science in Leukerbad', in S. Strauss and B. Orlove (eds), *Weather, Climate, Culture*. Oxford: Berg, pp. 39–60.
_____. 2009. 'Gobal Models, Local Risks: Responding to Climate Change in the Swiss Alps', in S. Strauss and B. Orlove (eds), *Weather, Climate, Culture*. Oxford: Berg, pp. 166–74.
Strauss, S., and B. Orlove (eds). 2003. *Weather, Climate, Culture*. Oxford: Berg.
Strauss C., and N. Quinn. 1997. *A Cognitive Theory of Cultural Meaning*. Cambridge: Cambridge University Press.
Taqiuddin, M. 2017. 'Struktur Sosial dalam Perubahan: Implikasi Pembelajaran Agrometeorologi dalam "Warung Ilmiah Lapangan" pada Dinamika Struktur Sosial Petani Tadah Hujan di Pulau Lombok [Social Structure in its Changing: The Implication of Agrometeorological Learning in the "Science Field Shops" on the Dynamics of Social Structure among Dry Rain-fed Farmers in Lombok Island]', Doctoral thesis. Depok: Universitas Indonesia.
Walker, S. 2017. 'Hand-out for Extension Trainers and Farmer-Facilitators in facilitating "Science Field Shops"', Unpublished manuscript. Translated into Indonesian by Y. T. Winarto. Depok: Centre for Anthropological Studies, Faculty of Social and Political Sciences, Universitas Indonesia.
Winarto, Y.T. 2004. *Seeds of Knowledge: The Beginning of Integrated Pest Management in Java*. New Haven: Yale Southeast Asia Studies.
_____. (ed.). 2011. *Bisa Dèwèk: Kisah Perjuangan Petani Pemulia Tanaman di Indramayu* [*We Can Do It Ourselves: The Story of Plant-Breeder Farmers' Strives in Indramayu*]. Depok: Gramata Publishing.
Winarto Y.T., and K. Stigter. 2013. 'Science Field Shops to Reduce Climate Vulnerabilities: An Inter- and Trans-disciplinary Educational Commitment', *Collaborative Anthropologies* 6: 419–41.
_____. 2016. 'Incremental Learning and Gradual Changes: "Science Field Shops" as an Educational Approach to Coping Better with Climate Change in Agriculture', in L. Wilson and C. Stevenson (eds), *Promoting Climate Change Awareness through Environmental Education*. Hershey, PA: Information Science Reference (IGI Global), pp. 60–95.
_____. 2017. 'Anthropology Teaming up with Agrometeorology: Getting University Science to Assist Farmers with Climate Resilience', *Asian Politics and Policy* 9(3): 479–92.
Winarto, Y.T., K. Stigter and M.T. Wicaksono. 2017. 'Transdisciplinary Responses to Climate Change: Institutionalizing Agrometeorological Learning through Science Field Shops in Indonesia', *Austrian Journal of South-East Asian Studies* 10(1): 65–82.
Winarto, Y.T., K (C.J.). Stigter and R. Ariefiansyah. 2017. 'Anticipating the Future', *Inside Indonesia* 127 (January–March). Retrieved 21 March 2021 from http://www.insideindonesia.org/anticipating-the-future-2.
Winarto, Y.T. et al. 2011. 'Towards Agrometeorological Learning? Responding to Climate Change, Evaluating Strategy', in Y.T. Winarto and K. Stigter (eds), *Agrometeorological Learning: Coping Better with Climate Change*. Saarbrucken: LAP LAMBERT Academic Publishing, pp. 181–215.

Winarto, Y.T. et al. 2018a. 'Nurturance and Trust in Developing Agrometeorological Learning in a Changing Climate', *Indonesia and the Malay World* 46(136): 360–81. Special Issue: Environmentalism and Environmental Education in Indonesia. DOI: 10.1080/13639811.2018.1502514.

Winarto, Y.T. et al. 2018b. *Institutionalizing Science Field Shops: Developing Response Farming to Climate Change.* Rome: GACSA, Global Science for Climate-Smart Agriculture.