

Introduction

Harro Maat and Dominic Glover

More than 150 million hectares of the earth's surface are planted with rice. Most of the rice fields are found in eastern and southern Asia, with lesser areas in Africa and the Americas. In the "rice societies" of Asia, where rice is widely grown and consumed, rice is not a singular object. It is simultaneously an important food crop, forming a large component of the daily food supply for millions of people, which is often considered a superior food even when alternative staple crops are available; a cultural symbol, associated with origin myths, folk tales, religious ceremonies, and cultural celebrations; and a source of income for farmers, millers, and traders. Together, these characteristics make rice an important public good that concerns policy makers, politicians, and publics. In various places, rice is even a means of artistic expression, for example, in Japan, where farmers exploit differences in the colors of rice foliage to create huge images in their fields, and in India, where rice grains are used to make mosaic-like artworks called *rangoli*. Last but not least, rice is an object of study for scientists, generating knowledge about rice as an organism, a crop, a grain, or a bulk commodity and prompting technical interventions to change the growth characteristics and nutritional composition of rice, cultivation techniques, processing methods, and distribution channels. Over the last hundred years, science and technology have affected rice in all its dimensions, thereby playing a pivotal role in the shaping of rice-growing and rice-consuming societies (Barker et al. 1985; Bray 1986).

The articles in this issue explore the interactions between rice, scientists, technologies, and societies from various different perspectives. By focusing on a single crop in settings as different as scientific laboratories and research stations, farmers' fields, markets, and the homes of rice consumers, the articles shed light on the diverse ways in which scientific research and technology development are played out in a variety of social, institutional, and technical contexts, the multiple meanings of rice in these contrasting settings, and especially the ways in which these distinct arenas are connected or fail to connect.

H. Maat (✉)

Technology and Agrarian Development Group, Wageningen University, PO Box 8130, 6700 EW Wageningen, The Netherlands
e-mail: Harro.Maat@wur.nl

D. Glover (✉)

Technology and Agrarian Development Group, Wageningen University, PO Box 8130, 6700 EW Wageningen, The Netherlands
e-mail: Dominic.Glover@wur.nl

1 The Materiality of Rice

The articles share a focus on the materiality of rice, which manifests differently in different settings. For example, in a molecular biology laboratory *rice* might mean a solution containing crushed leaf material that is made meaningful through processing and transcription using various instruments. In a field experiment, different parts of the plant or crop—the roots, the leaves, the panicles, the grain, and so on—may become salient at different times during the growing season, depending also on the influence of other organisms, water, fertilizer, and the weather, as well as various actors, agencies, or institutions, such as fertilizer companies, extension services, or markets. In the home, the storage characteristics, texture, aroma, or stomach-filling qualities will be prominent. The authors' shared focus on materiality brings the entity rice itself into a sharp focus and makes it possible to see connections and highlight contrasts between the different settings where it interacts with human beings and other actors. The collection of articles thus underlines the value and importance of taking materiality seriously as a focus of study for the social sciences and humanities, which have typically taken a more interpretive approach, and not only for the natural sciences.

The goal of our joint effort is to explore possible links between the insights of science and technology studies (STS) and anthropology, which often come together in the field of international development studies. Two scholars whose work has inspired us to connect these fields are Francesca Bray (1986) and Paul Richards (1986), whose seminal work on rice cultivation and rice societies has drawn upon both anthropological insights into material culture and sociological insights into science and technique. Before introducing the articles in this collection, we highlight some of the insights that stimulated us to use the concept of materiality as a thematic focus for this issue.

2 Materiality and STS

The point of departure in STS is that science and technology (or “technoscience”) constitute forms of practice that are not intrinsically different from any other social practice, although their particular institutional and material shapes and forms are distinctive. Material artifacts have a prominent place in the scientific and technological practices studied by STS. All kinds of material objects are dealt with by technoscience—large and small; solid, liquid, and gaseous; living and inanimate; singular and composite. Some of these objects are the focus of great attention by technoscientists, for example, a collection of biological samples or the instruments in a laboratory. Other objects play key roles in science and technology without attracting much attention in their own right, such as the notebooks in which data is recorded or the computer networks through which data is transmitted. The importance of material objects in the social worlds of science and technology has stimulated the development of a number of original concepts and theoretical positions by STS scholars, in an effort to accommodate the simultaneously social and material nature of technoscientific practice. For example, actor network theory, developed in the 1980s by Michel Callon and Bruno Latour (1981) and John Law (1986), rejects any fundamental distinction between human and nonhuman actors. This position is epitomized in the notion of the “actant,”

defined as “whatever acts or shifts action.” Other STS scholars have stressed the combined social, biological, and technical construction of human bodies, captured by Donna Haraway (1990) in the concept of the cyborg, or the agency of other forms of nonhuman or not-yet-fully-human creatures, conceptualized by Sheila Jasanoff (2005) as “liminal agents.”

Other STS scholars who have paid close attention to materiality have explored the capacity of objects or technological artifacts to mediate between different practices or social worlds. The concept of the “boundary object,” as developed by Susan Leigh Star and James Griesemer (1989), denotes an interaction whereby two or more different communities of practice can be connected through the shared use of the same object, even as each community may also use the object in a different way. Material objects may also become a source or target of conflict or contestation between groups, as in the case of transgenic crop technologies (Schurman and Munro 2010). The STS literature contains many examples of the individual or collective appropriation and reshaping of technical artifacts or other objects, thus expressing the opposing views of different social actors or, very often, exposing the distinctions between the designers and users of technologies (Akrich 1992; Mackay and Gillespie 1992; Oudshoorn and Pinch 2003). Nonetheless, where many STS studies have thus emphasized the malleability and interpretive flexibility of objects, other scholars have, at the same time, pointed to the obduracy and momentum of objects, especially the integration or embedding of systems of infrastructural technologies (Hughes 1987; Hommels 2005).

3 Anthropology and STS

STS insights into the materiality of objects and technological artifacts cut across geographical and temporal scales (Misa 2009). Nevertheless, STS scholarship has in the past been preoccupied with U.S. and European contexts, while development studies scholarship has rarely paid explicit attention to the nature of technoscience, despite the fact that so many development interventions are highly technocratic. Anthropologists, on the other hand, have a long-standing interest in material culture. By focusing on materiality in relation to rice in the Asian rice societies, the articles in this collection attempt to bring together these intellectual fields. The articles not only reflect the various ways in which STS has grappled with materiality but also demonstrate the relevance of STS insights to development studies as a field and to geographical and institutional settings outside the United States and Europe.

STS notions of materiality and its sociological roles are in certain respects similar to, and sometimes incorporate, anthropological accounts of the role of material culture in human activity. Where STS generally focuses on fields in which scientists and engineers are dominant social actors, however, anthropology is, at least in principle, indifferent to the types of human activity or social interaction to be investigated. Material culture studies is the major branch of anthropology that gives a central place to artifacts, that is, to materiality. Material culture studies has thus explored a wide variety of recursive relationships between persons and things. Anthropology’s long tradition of interrogating material objects as important sources of information about human activity and thought has given rise to numerous theoretical propositions. The *Handbook of Material Culture* lists ten major conceptualizations of materiality,

including material objects made and used by individuals or collectives and the relation between human individuals and things, their minds and bodies, their cultures and societies, and their histories (Tilley et al. 2006: 4). Technologies and objects emerging from scientific practices are also implicated in these conceptions of materiality. Material culture studies recognizes the importance of science and technology in changing material objects as such, as causes of change in social and material orders, and as forces shaping the activities and dynamics within material cultures (e.g., Appadurai 1988).

When comparing the concepts and insights developed in material culture studies with those arising from STS treatments of materiality—in a far from systematic way—we observe various similarities and overlaps. These similarities make clear that exchange between the two fields is viable and worth pursuing. It should be noted, to begin with, that the theoretical concepts developed within STS are not exclusively relevant to high-technology settings such as laboratories or suspension bridges but may include banal, everyday objects such as hotel key fobs or door closers (Latour 1992). Given the central focus on science and society interactions in STS, both everyday objects and “lay knowledge” are familiar concepts for STS scholars.

Within the anthropological literature, too, notions of materiality and technology come together. One of the foundational books of material culture studies is Marcel Mauss’s *The Gift* (1990), which analyzes how social relationships may be created and sustained by the exchange of objects. Much less known is Mauss’s work on technology (or technique), recently collected in an English-language volume by Nathan Schlanger (Mauss 2006). Mauss considered the human body itself as the basic and fundamental form of technology, and all other forms of technology and tool use as extensions of human capacity. Authors following Mauss’s lead have emphasized the importance of skills, as embodied in individuals, and the combination and complementarity of individual skills in labor gangs, “task groups,” or other forms of teamwork (Sigaut 1994; Jansen and Vellema 2011). This anthropological focus on technology as human technique or skilled activity creates an opening for symmetrical analysis of the material interactions involved in very different sociotechnical settings, for example, rice cultivation in an isolated rural area and the activities of molecular biologists using expensive instruments to tinker with the genetics of rice in the laboratory (Richards et al. 2009).

The anthropological perspective on technology initiated by Mauss has also proved helpful in understanding the movement of objects between different contexts. Underlying this movement, expressed in the notion of a boundary object, is some level of shared meaning. As explored in the work of Tim Dant, creating such shared meaning is not an abstract perceptual act but involves bodily activity. Observing car mechanics at work, Dant noticed that manuals provided them with only limited information. Much of their understanding of what the problem was and how to solve it emerged from touch and sensation. These bodily movements or gestures are essential for understanding and effectively using objects (Dant 2007). Likewise, the movement of objects between different arenas requires bodily activity on both sides. The pictures in Japanese rice fields, or any other works of art, require a great deal of skilled work by an artist and his or her assistants to convey the intended message or emotion. As the work passes into the hands of the viewer, he or she also has bodily work to do, including finding one or more vantage points from which to view the work and

consider it from different angles and distances (Dant 1991). The kind of bodily activity and the amount of skill this requires are specific to the object and its context.

4 Materiality in Research, Knowledge, and Practice

The reflections discussed here return in the articles collected in this issue, both directly and indirectly. In all of the articles, the interaction between rice and human agents is central. In some cases, intractable characteristics of rice and rice cultivation oblige human actors (scientists, development workers, farmers, and others) to make adjustments to or curtail their plans, as in the different cases described in the articles by Kuei-Mei Lo and Hsin-Hsing Chen, Sally Brooks, and Dominic Glover. On the other hand, human agents are shown imposing their will on rice to varying degrees, treating it in remarkably different ways in different settings in order to achieve particular goals, as pointed out, for example, by Brooks and Glover. Moreover, rice is seen to play the role of a boundary object linking different social worlds, exemplified in the studies presented by Brooks and by Chris Shepherd and Andrew McWilliam. Embodied skill is highlighted in all four of the articles, as human actors try to find ways of growing, harvesting and processing, marketing, and consuming rice to achieve particular ends. In the process, the simple category “rice” is repeatedly opened up to reveal its diverse and complex materiality. Across a range of different practices and contexts, the authors develop different perspectives and apply different concepts to analyze the interaction between rice and human agents.

Kuei-Mei Lo and Hsin-Hsing Chen explore the embeddedness of Taiwan’s rice cultivation system, using the concept of technological momentum that was first introduced by Thomas Hughes (1987). Lo and Chen’s article examines the attempt by a range of actors to develop a space for organic rice production in Taiwan. Organic farming was proposed as a radical transformation of the Green Revolution rice farming system that was established in Taiwan, fostered by Western powers, during the Cold War. Lo and Chen’s analysis exposes the difficulties involved in the attempt to reorient a system that was established around the supply of agricultural chemicals and fertilizer-responsive rice varieties. The effort to develop a space for organic rice farming required the cooperation of numerous actors and some key technological changes. These included a switch to alternative rice varieties that were more suitable for organic farming methods, but aspiring organic farmers also had to grapple with a tightly integrated infrastructure of information, machinery, and other agricultural inputs that were attuned to the existing system. In Taiwan, farmers and various material objects are connected by cooperatives or dependent on local commercial suppliers, through which they can access farm machinery, planting material, other inputs, and services. These relationships also connected the aspiring organic farmers to social and information networks that were sometimes skeptical about or hostile to organic farming methods. Moreover, though individual farmers may choose to stop using inorganic chemicals, in an industrialized nation such as Taiwan residues from neighboring farms or regions can easily enter rice fields along with irrigation water. As Lo and Chen show, the complexity and intractability of these relationships placed heavy demands on collective action involving a variety of stakeholders who, in spite of their

organizational capabilities, failed to bring about substantial change in the conventional rice farming system.

Sally Brooks takes us to the lion's den of the Green Revolution, the International Rice Research Institute in the Philippines. The researchers who occupy a central place in Brooks's article hoped and strove to get a number of material and social actors to cooperate in the creation of a new type of rice that would improve the health of iron-deficient rice consumers. In the course of their research, scientists identified a rice strain that seemed to have a high iron content in its grains. Later, the identity of this "high-iron rice" came into question; the trait seemed to be inconsistent, and the original readings proved difficult to repeat. Had there been a measurement error? Or was it the case that the high-iron trait depended on environmental interactions rather than the genetics of the rice variety alone? Brooks's account of the project shows how different scientific disciplines gave rise to competing theories about how iron could be made to accumulate in the endosperm of rice, and thus differences of view concerning the mechanisms and tools to focus on. The researchers also realized that the achievement of a high-iron rice was only the first part of the puzzle. The iron had to be made to transfer successfully from the rice grain to the human body. This demanded a completely different research environment, which involved a community of nuns, special milling and cooking procedures, and blood samples. As a consequence of the many challenges faced within the research program, relatively little effort was made to connect the research to the outside world, except in order to build relationships with financial donors. In the process, the high ambitions of the research program were scaled down to a "proof of concept." As Brooks points out, *proof of concept* represented a boundary term that allowed for effective interaction between program managers and donors. However, this move also weakened the connections between the scientists and the rice farmers and consumers in developing countries who were supposed to be beneficiaries of the research program.

Establishing an effective connection between research outcomes and rice farmers is also central to the article by Chris Shepherd and Andrew McWilliam. They discuss two projects in East Timor, both of which aimed to convince farmers of the benefits of adopting an improved rice variety. While their article explores the relative value of different anthropological perspectives, the authors make explicit use of actor network theory in analyzing two projects that created and reshaped actor networks in very different ways. The projects' relationships with farmers were mediated by the improved rice varieties but also involved various other material objects. Indeed, in one project, the absence of material proved as important as its presence: farmers were promised benefits in the form of money and two-wheeled hand-tractors, alongside the new rice variety, but few tractors were distributed and little money was paid out. Extension workers hardly showed up either, compounding the project's failure to gain the farmers' trust and confidence. Shepherd and McWilliam's second case study was apparently more successful. In this project, extension workers visited farm sites more frequently and over a longer period, and focused on a wider range of rice cultivation activities. The authors show that the project relied less on outside expertise, did not seek to create new groups, offered no inducements, and used less of the farmers' land for crop field trials. Much more emphasis was placed on enabling the farmers to observe and evaluate the performance of the new rice variety for themselves, through careful demarcation of trial plots within the farmers' fields and carefully

orchestrated yield measurements conducted on site. Shepherd and McWilliam's analysis of these two projects reveals the amount of work involved in successfully transferring improved rice varieties from agricultural research institutes into farmers' fields and working practices. Shepherd and McWilliam argue that the designers of both projects implicitly assumed that the new rice varieties would be embedded into farmers' cultivation systems once the project interventions came to an end; follow-up studies will be required in order to see how actor networks are actually reconfigured when extension support is withdrawn.

The difficulties involved in connecting rice research to rice farming are also explored in the article by Dominic Glover. The article discusses the origins of the System of Rice Intensification (SRI), an alternative and controversial method of rice cultivation, which was developed in Madagascar during the 1970s and 1980s and has since spread internationally. Glover shows that SRI was strongly shaped by the circumstances in which it was developed, in a setting characterized by constrained institutional and socioeconomic conditions and the relative isolation of a poor developing country that was largely disconnected from the international agricultural research system. Under these limitations the originator of SRI, Father Henri de Laulanié, fell back on an inductive type of scientific research that entailed close observation of rice plants and how they grew in Madagascar, as well as intimate engagement with the physical and technical capacities of poor and marginal Malagasy rice farmers. SRI was thus deeply embedded in its material and institutional context, in the absence of strong connections to the leading international centers of rice research. Given the circumstances of its development, Glover shows that it is hardly surprising that de Laulanié's rice cultivation methods differed from those recommended by established international agricultural research institutions, or that they sparked a negative reaction from scientists associated with those organizations. Some rice scientists dismissed SRI as a compilation of unremarkable good agronomic practices with some practices of dubious merit that, as a package, could not contribute to the scientific quest to advance the frontier of rice agriculture. Like the article by Brooks, Glover's article thus highlights the competition that exists between alternative strategies for the scientific improvement of rice production, those that focus on genetic improvement of rice plants and those that aim to improve cultivation methods in farmers' fields.

5 Conclusion

The articles in this issue shed light on the degree of variety that exists in the ways that different scientific and production strategies interact with the materiality of rice and rice technologies in different sociotechnical and geographical contexts. Together, the articles indicate the fruitfulness of linking concepts and approaches drawn from STS and anthropology, applied to the kinds of projects, programs, and problems typically addressed by scholars working in development studies. The authors' common focus on Asia's major food crop demonstrates the utility of exploring a material object and its associated sociotechnical systems, as a way to understand and explain the differences that social contexts, strategic goals, and institutional methods and strategies make to the conduct of agricultural research, development, and extension.

References

- Akrich, Madeleine (1992). The de-scription of technical objects. In *Shaping technology/building society: Studies in sociotechnical change*, edited by Wiebe E. Bijker and John Law, 205–24. Cambridge, MA: MIT Press.
- Appadurai, Arjun, ed. (1988). *The social life of things: Commodities in cultural perspective*. Cambridge: Cambridge University Press.
- Barker, R., R. W. Herdt, and B. Rose (1985). *The rice economy of Asia*. Washington, DC: Resources for the Future.
- Bray, Francesca (1986). *The rice economies: Technology and development in Asian societies*. New York: Blackwell.
- Callon, Michel, and Bruno Latour (1981). Unscrewing the big leviathan: How actors macro-structure reality and how sociologists help them to do so. In *Advances in social theory and methodology: Toward an integration of micro- and macro-sociologies*, edited by K. Knorr-Cetina and A. V. Cicourel, 277–303. London: Routledge and Kegan Paul.
- Dant, Tim (1991). *Material culture in the social world: Values, activities, lifestyles*. Philadelphia: Open University Press.
- Dant, Tim (2007). The “pragmatics” of material interaction. *Journal of Consumer Culture* 8: 11–33.
- Haraway, Donna J. (1990). *Simians, cyborgs, and women: The reinvention of nature*. London: Routledge.
- Hommels, Anique (2005). *Unbuilding cities: Obduracy in urban sociotechnical change*. Cambridge, MA: MIT Press.
- Hughes, Thomas P. (1987). The evolution of large technological systems. In *The social construction of technological systems: New directions in the sociology and history of technology*, edited by Wiebe E. Bijker, Thomas P. Hughes, and Trevor J. Pinch, 51–82. Cambridge, MA: MIT Press.
- Jansen, K., and S. Vellema (2011). What is technography? *NJAS Wageningen Journal of Life Sciences* 57 (3–4): 169–77.
- Jasanoff, Sheila (2005). *Designs on nature: Science and democracy in Europe and the United States*. Princeton, NJ: Princeton University Press.
- Latour, Bruno (1992). Where are the missing masses? The sociology of a few mundane artifacts. In *Shaping technology/building society: Studies in sociotechnical change*, edited by Wiebe E. Bijker and John Law, 225–58. Cambridge, MA: MIT Press.
- Law, John, ed. (1986). *Power, action, and belief: A new sociology of knowledge?* London: Routledge and Kegan Paul.
- Mackay, H., and G. Gillespie (1992). Extending the social shaping of technology approach: Ideology and appropriation. *Social Studies of Science* 22: 685–716.
- Mauss, Marcel (1990). *The gift: The form and reason for exchange in archaic societies*, translated by W. D. Halls. New York: Norton.
- Mauss, Marcel (2006). *Techniques, technology and civilization*, edited by Nathan Schlanger. New York: Berghahn.
- Misa, T. J. (2009). Findings follow framings: Navigating the empirical turn. *Synthese* 168: 357–75.
- Oudshoorn, Nelly, and Trevor Pinch, eds. (2003). *How users matter: The co-construction of users and technology*. Cambridge, MA: MIT Press.
- Richards, Paul (1986). *Coping with hunger: Hazard and experiment in an African rice-farming system*. London: Allen and Unwin.
- Richards, Paul, et al. (2009). Seed systems for African food security: Linking molecular genetic analysis and cultivator knowledge in West Africa. *International Journal of Technology Management* 45: 196–214.
- Schurman, Rachel, and William A. Munro (2010). *Fighting for the future of food: Activists versus agribusiness in the struggle over biotechnology*. Minneapolis: University of Minnesota Press.
- Sigaut, François (1994). Technology. In *Companion encyclopedia of anthropology: Humanity, culture and social life*, edited by Tim Ingold, 420–59. London: Routledge.
- Star, Susan Leigh, and James R. Griesemer (1989). Institutional ecology, “translations” and boundary objects: Amateurs and professionals in Berkeley’s Museum of Vertebrate Zoology, 1907–39. *Social Studies of Science* 19: 387–420.
- Tilley, Christopher, et al. (2006). *Handbook of material culture*. London: Sage.