A Green Revolution from below?

Science and technology for global food security and poverty alleviation

Prof. dr. Paul Richards

Farewell address upon retiring as Professor of Technology and Agrarian Development at Wageningen University on 18 November 2010

WAGENINGEN UNIVERSITY

WAGENINGEN UR

A Green Revolution from below?

Science and technology for global food security and poverty alleviation

PROF. DR. PAUL RICHARDS

Farewell address upon retiring as Professor of
Technology and Agrarian Development
at Wageningen University on 18 November 2010

WAGENINGEN UNIVERSITY
WAGENINGEN UR

ISBN 987-90-8585-885-0

A Green Revolution from below?

Science and technology for global food security and poverty alleviation

Rector Magnificus, Ladies and Gentlemen

What is technology? Some people answer in terms of artefacts. For them, technology comprises tools, machines, processes. In the Technology and Agrarian Development group (TAD) we would answer differently. Technology is technique. It is knowing how to do something.

The approach comes from the great French sociologist, Emile Durkheim. In a voluminous output of books and papers Durkheim himself only ever wrote one paragraph about technology. It says if you want to understand society technology is important (Schlanger 2006). This might seem a hazardous basis on which to found an entire research approach.

Durkheim never got round to filling the space he had marked, dying relatively young during the Great War. It was left to his nephew, the anthropologist Marcel Mauss, to develop the Durkheimian approach to technology. Mauss published a paper in the 1930s called "The techniques of the body" (Mauss 1936). Technique begins with the body. The body is our first tool. It is through the body that we shape the world. The tools, machines, processes, as so often summed up under the word "technology", are all extensions or enhancements of embodied capacities.

In the Technology and Agrarian Development group we like to illustrate this basic approach by referring to a study by Lucy Suchman. Suchman carefully observed how people use photocopiers (Suchman 1987). The first rule of photocopier use is that the machine never breaks down except when you are late with a large item. On our corridor the copy-printer has a big notice hanging above it: "if this machine breaks down do not try and fix it yourself; you are not clever enough. Go get a secretary to help you" (or words to that effect). But we can't resist. We stab at switches and buttons in random panic. Regardless of safety, we grab drawers and

. . .

windows, anything that moves, prize them open, and start to grope around feverishly inside. No improvement, or the occasional electrocution, results. It is not long before we resort to kicking or shaking the machine. If the machine wasn't seriously damaged to start with, it is now.

Now it is true that secretaries generally can fix these things. On our floor we have particularly wonderful breed of secretary-technician-magician. But you could probably fix it yourself, if you had the time to locate the manual and apply its diagnostic advice. No one has the time, and the manual has gone missing in any case. So, repeatedly, machines are out of order.

To remedy this situation photocopy designers wanted to change users. But Suchman tried to get the designers to accept that users were never going to operate the machine according to the book. What was needed was not to educate the users to fit the machine but to redesign the machine to respond to the way users use (or abuse) it.

I will have to admit photocopiers are still not perfect in this regard, but those with long memories will probably agree today's machines are more intuitive in the way they interact with our clumsy, hasty attempts to fix the paper jam that is timed unerringly for Friday afternoon at 17.30, just after the secretary has gone home for the weekend, and you are late with copies of a paper for a conference you would have attended if you had not by now just missed your plane. Today's machines are also much more robust. Kicking the photocopier no longer results in a week-long machine seizure (even if your foot now suffers as a result).

This type of anthropology of technology, increasingly common in engineering design, grows out of the Durkheimian legacy, in which the first move is to understand human projects in terms of embodied capacity and intentionality.

This requires – as the story of the photocopier implies – serious investment in observation; specifically, observation of interactions between user and artefact. How do humans actually use tools, and machines, or plants, animals and bio-processes? In the TAD group we call this technography.

When anthropologists and sociologists study and document communities they term their work ethnography. By extension, the study of people and communities interacting with machines, tools, plants, soils and so forth can be termed "technography". Suchman's study, on this reckoning, is the first technography of a widespread social disease – serial photocopier abuse.

Technography, as we envisage it (Richards & Vellema, in progress) has four levels (materiality, task groups, professions and interactions between professions and communities). The TAD group mainly studies the first two – materiality and task groups.

The higher levels are covered by other Wageningen research groups as well, and we are happy to cooperate on important topics such as pesticide regulation, biodiversity conservation, and consumer reactions to genetically-modified organisms. Where as a group we are distinctive is in the degree of emphasis we place on the study of human embodied capacity to effect material transformation, and on task group organization as a basis for carrying out complex, cooperative tasks of material transformation.

Working in an under-cultivated field it is a constant preoccupation to locate material from which to teach. We have a small treasure trove of books and articles in which materiality and task groups are taken seriously. On materiality, this would include Suchman's book, and Dant's perceptive account of the materiality of car repair (Dant 2005). For analysis of task groups we rely on an important but neglected book by McFeat on small group task-oriented cultures, which includes an account of a pioneering experiment in generating such cultures (McFeat 1972).

Experimentation is worth an additional comment. The social sciences approach to experimentation (e.g. Henrich et al., 2004) is something that as a group we take particularly seriously, in a university where cross-disciplinary research is encouraged and experimentation is the norm in the life sciences. This aspect of our work led in 2009 to a successful PhD training workshop on experimentation organised jointly with Development Economics group, and is something, I hope, that will be revived. Experimentation – at root, a word meaning "to try and see" – seems especially important to a group in which it is argued that technology is not something calculated or imagined but emergent in hands-on human action.

But what – you might wonder – has all this got to do with global food security and poverty alleviation? Here I reach the nub of what I want to say in this address.

Let me again allude to Durkheim. Durkheim was a social thinker who asked fundamental questions about the nature of social solidarity. He foresaw that as human interaction, driven by division of labour, widened its geographical scope it would have to be accompanied by a more generalised, global sense of social responsibility. We may be far yet from feeling citizens of Europe, let alone the world, but it is nevertheless remarkable how in the post-1945 period a sense of international solidarity has begun to take root. Earthquakes, tsunamis and wars have always devastated human communities – especially the lives of the poor. Modern consciousness increasingly demands that something should be done about it. A sense that every human being has certain basic rights to survival and freedom from want has grown, even among people who otherwise wish to protect national identity and end international migration.

Durkheim (contra Marx) argued that while there was a sense of society, religion would never disappear (Durkheim 1995 [1912]). But he also argued that the future of religion lay not in dogma but in action. His entire theory of religion can be summed up in a line – belief emerges from action. Do it and you will think it. You believe because you pray, not the other way round. Thus Durkheim anticipated that future religion would be a set of ethical principles based on human interaction – in a phrase, human rights. It is this modern secular religion that drives the debate about Millennium Development goals, and with it the specific international ambition to end hunger.

Amazingly, there is little or no dissension concerning the goal. This was not always the case. The post-1945 projects to end global hunger and poverty only came into being when Malthusian voices were finally overcome, under the pressure of the Cold War (Perkins 1997). The Malthusians had argued that hunger was Nature's way of controlling population increase. Science-based reduction of hunger would undermine a necessary natural check. That this idea now seems so antiquated is a measure of how far global economic inter-dependency, and attendant notions of international social solidarity, have come in the last 50 years. There is today no argument that population pressure, including the pressures exerted on the planet by gas-guzzling Westerners, must be solved through technological means. We have to get smarter in our use of finite resources. The only issue is how.

This is where – in regard to food and poverty – disagreement sets in. There are many who would argue that the world saved itself from mass starvation in the 1960s and '70s through the Green Revolution – a label applied to the chemical-intensive quick-ripening rice and wheat seed technologies generated by international public science. Supporters say that we now need a second Green Revolution – based on the same institutional prescription (a top-down approach to technology as a public good, though perhaps this time with participation by the private sector also).

Opponents ask "what about China and Africa?" China (a recent study suggests) went through an endogenous, bottom-up food security revolution based (initially at least) on the mass mobilization of peasant skill, once a disastrous experiment in Soviet-style farm collectivization had been rejected (Shen 2010). In Africa, where soils are poor and irrigation less feasible, the Green Revolution never really arrived (Richards 1985), and it is in Africa that we now find some of the worst problems of agrarian poverty and food insecurity.

An argument also rages about what sort of technology is required. Both sides in this argument agree new technologies are required, but profoundly disagree about the approach to be deployed. Some see genetic modification of crops as the answer. Others argue that organic technologies can feed the world. What is striking about this debate is that opposed sides both place their faith in external inventions. In the jargon of the social sciences they essentialize technology, seeing it as something that brings benefits, in and of itself. From this perspective, a food-security revolution is something to be designed far way, and delivered in a package, like a flat-screen TV.

Neither side in this argument – our group believes – has yet taken on board the lesson of photocopiers. Both proponents of genetic modification and organic enthusiasts embrace a view of technology as something requiring user to adapt to machine. A stress on technology as skill and technique shifts the focus. Technologies for food security have to be robust and self-explanatory enough to withstand a good kicking in use. We need malleable components that adapt themselves to the needs and purposes of users, not entire ready-made systems. Perhaps, in fact, we need a technology revolution that emerges from the needs and purposes of the users themselves. This amounts to call for a food security revolution from within.

Perhaps at this point I need to clarify some of my own work. About 25 years ago I published a book on what farmers in Africa knew about plants, pests and soils (Richards 1985). I had long felt such a book to be necessary because so many people put down poverty and hunger in Africa to farmer ignorance. It was widely argued that hunger would be solved if only the agrarian poor could be persuaded to abandon old and ineffective techniques and planting materials, and adopt the new seeds coming from the international public research institutes.

My book tried to point out that ignorance was not the source of the problem, because in fact farmers in remote African communities were skilled in making the best use of limited resources. If they rejected new seeds it was not because they knew nothing about farming, but (in a sense) because they knew too much – they readily discovered disadvantages in Green Revolution technologies that researchers had failed to anticipate. African rice farmers knew for example that the new wetland rice technologies were often labour intensive, when their own main problem was not lack of land but lack of labour.

Non-governmental organizations involved in rural development, and the organic farming movement, took me to be saying that science was not needed, because local knowledge was sufficient. What I actually argued was that African farmers were often experimental in outlook, and keen to respond to new opportunities, rather than mired in tradition and taken-for-granted ways of farming. Thus (I suggested) farmers could be counted as collaborators in a technological revolution from below. To set the parameters for that revolution we needed to pay close attention to the experiments African farmers undertook (Richards 1989).

Being misunderstood taught me a lesson. The French post-structural literary theorists argue that books are not made by writers but by readers. What I learnt is that some books are not made by either writers or readers, but by people who form judgements from titles alone. I had wanted to call the book *People's Science*, arguing for "plebeian science", something that flourished in working-class communities in England (and elsewhere) in the 19th century. Alfred Russell Wallace, the co-originator of "Darwinian" evolutionary theory, was an affiliate of this tradition (Barrow 1986). My publisher rejected the title, claiming booksellers would not know where to shelve the book. He preferred *Indigenous Agricultural Revolution*, with the result that the book became a point of reference for an anti-science element in international development.

A move to Wageningen in 1993 was chance to repair this unintended damage. Let me repeat. Impoverished African farmers belong, through their everyday actions, to the world of science. This should not only be recognised, but should be the point of departure for any programmes of science and technology aimed at food security and poverty alleviation. On the other hand, I no more expect small-scale farmers or landless peasants in Africa, Asia and Latin America fully to develop science-based technologies through unaided efforts than I expect busy academics to sit down and redesign photocopiers in their spare time. The point is to recognise that users contribute as much to effective technology design as engineers. What matters, in terms of robust and effective technology to extend embodied human capacities, is the nature of the relationship between engineer and user. Engineers open to feedback stand to gain a great deal from users, in terms of effective design, even if this feedback may at times challenge their basic assumptions.

Our own group, therefore, tries to look both ways in research, seeking to assist the mutual accommodation needed between designers and users of agrarian technologies. We try to understand how engineers struggle with materiality. Not everything desirable can be designed, and this as true of plants as of photocopiers. But we also pay attention to task-group cultures in the design process. If feedback is important it has to be accommodated, and that means not only having the means to gather data from users but also organizing a collaborative social setting through which users can convey meanings and intentions to designers.

Looking towards users, we try to understand the material realities faced by farmers, and their own struggles with recalcitrant nature. Farmers (and farm workers) sometimes can, and sometimes cannot, describe infertility of soils in terms recognizable to soil scientists or plant pathologists, but they nearly always know soils and field micro-variation, including which parts of a field are prone to sudden flooding, or which parts of a swamp are likely to develop iron toxicity problems. Similar local knowledge exists for pests and diseases, and awareness of biohazards. Sometimes farmer hazard assessments can be understood only in terms of contextual factors. Field workers spraying bananas may well be aware of toxicity problems, but are loath to wear protective gear that has not been properly designed for long-term wear in humid tropical field conditions.

Furthermore, much of what farmers and farm labourers do (as opposed to what science or regulatory authority tells them to do) is based on practical contingencies of task group organization (whether a farmer belongs to a labour sharing club, or not, for example), or it relates to unavoidable social responsibilities to dependants or a wider community group. For instance, a high-yielding crop type may be rejected in favour of a range of local low-yielding types, because the high yielding type does not fit local patterns of labour availability, or produces only at a single season, or has the wrong consumption or storage characteristics. This implies very careful study of local genotypes to understand what makes the local breed effective in context (and what aspects are locally seen as limiting). And yet time and again this local information is neglected.

To measure the extent of the problem we are currently planning a meta-study of the crop experimental literature, to document how often experiments testing the effectiveness of new plant types are set up against vaguely described "local varieties". Already, in a preliminary and unsystematic trawl we have encountered a good deal of vagueness about controls. This vagueness seems symptomatic of a feedback problem. If you really want to know if an improved cultivar really is improved then every scrap of possible information concerning the properties and patterns of usage of the best local types should be gathered from a range of users of different ages, classes and genders, and these best local types should be introduced into the experiment as relevant controls. Yet controls are often barely described – sometimes not even named.

Our aim in looking both ways – at agrarian engineers and users of agrarian engineering – is the hope of closing a gap. This gap, I want to make clear, is more than a problem of communication. It is a gap in science itself. To arrive at a new understanding we need to address both the history and content of science. I will make two points.

First, we often have too parochial a view of the origins and development of science. We talk in this university about "science for impact". This means – as a glance at the student body represented in this hall will reveal – linking science across continents. We end up working with users in regions with important traditions of science that tend to be marginalised in our own thinking. I cite only the contributions made by the Islamic world, India and China, and refer you to the *Encyclopedia of the History of Science, Technology and Medicine in Non-Western Cultures* (Selin 1997) for further detail. The point I want to make is that in being too parochial in our own understanding of where science comes from we disable ourselves from a very important source of feedback. Francesca Bray's seminal book, *The rice economies* (Bray 1986), offers important guidance.

Professor Bray is an historian as well as anthropologist of rice technologies. Drawing on ancient textual evidence as well as modern farming systems fieldwork her book was able to make the crucial point that the development of agrarian technologies in the rice lands of East and South-east Asia followed a different path to those pursued in Europe and North America. The Asian trajectory was one of knowledge intensification rather than land or labour intensification. The relevant Chinese phrase – *Jinggeng Xizuo* – is translated by Shen (2010) to mean "skill oriented precision farming". It is agrarian technology with a mass base – embodied in the eyes and hands of many generations of rice planters. The standard agrarian development scenarios resulting from European or North American experience focus on land or machines, and thus underestimate the eye for detail essential to understand emergence of skill-intensive wetland rice farming in the East.

Bray goes further. The product of knowledge intensification in China and Japan over many centuries was a system of double cropping of wet land rices that, with adaptation to tropical (as opposed to sub-tropical) conditions, became the Green Revolution rice farming system so successfully introduced across much of South and South-east Asia in the 1960s and '70s. In effect, the new system spread effectively because it was already pre-adapted to local usage. It was a photocopier already made robust by generations of local action.

A conclusion seems in order that it is always good to know the local history of technology and society when designing science for impact. Western governments and the private foundations are busy re-launching the Green Revolution. A fully contextualised global history of variant pathways to agrarian change should be mandatory for any such re-launch. Happily, a historical thread is strongly established within the work of the TAD group, and I am confident it will continue to grow.

The second point concerns the cutting edge of science. Science is a living thing. As new discoveries are absorbed old certainties require to be revised. One of the old certainties in biology requiring revision was the mid-20th century assumption that evolution was primarily about fixed species (Mallet 2007). Species were natural kinds. Appear and disappear over time they might, but they did not melt or meld into each other. This notion is so fixed in public consciousness that transgenic manipulation is today equated to original sin.

Wind forward to the first decade of the 21st century and science has changed. No longer is the hybrid an anomaly in evolutionary schemes (Mallet 2005). Biologists now contemplate allocating a much more important role to horizontal gene transfer in evolutionary processes – e.g. transduction by virus or transfer by means of a plasmid. Evolution itself is powered by something much murkier and messier than simple descent. The “tree of life” seems an increasingly antiquated conceit.

This in turn revises, or should revise, our view, of biotechnology as a tool for transformation of human livelihoods. If "Frankenfoods" are the product of mad scientists tampering with organic nature then it appears that Mother Nature has been using the same gene-shifting techniques for far longer. Hybridity is everywhere – whether of the intra-specific kind seen in the United States presidency, or the inter-specific kind found among the three-quarters of British duck species capable to form viable hybrids with other species of ducks.

Of course objections will still persist. Some British conservationists remain intent on extirpating the alien Ruddy Duck for fear it will hybridise the British native duck population. But from a biological point of view, hybridity is irrefutably an important part of how the world is and how the world has come to be. The United States repealed in the 1990s its conservation legislation of 1973 declaring hybrids to be of no conservation value (Mallet 2005). Species are increasingly recognised as a taxonomic convenience, indexical only of a relative stability, in a complex evolutionary world in which descent is not the only game in town. Genomics now allows us to untangle, if we will, the story of broad outcrossing that affects much of the living world.

Indigenous knowledge has long been part of this story of hybridity. Farmers routinely assist hybridizing events among many crop plants and animals. This is apparent from the inter-specific origins of modern wheat. But until recently we have not known very much about the process in other major grains such as rice. Now, there is a specific story to tell in regard to hybridity in rice.

Two species of rice grow in West Africa – African rice (*Oryza glaberrima*) domesticated in the region and Asian rice (*O. sativa*) imported to the West African coast during the era of the slave trade. During the 1990s various researchers reported intermediate morphotypes among the rices planted by African farmers. More recently, some genomic evidence has been published to confirm the existence of farmer hybrids.

In 2009 Wageningen researchers coordinated by the TAD group (Nuijten et al., 2009) analysed 315 rices collected in coastal West Africa from Senegal to Togo, and

. . .

identified about forty farmer varieties of hybrid-derived origins, using AFLP markers (Figure 1). These farmer rice hybrids were distributed from The Gambia to Sierra Leone. Divided over two distinct clusters, and with a presumed origin in Sierra Leone and/or Guinea Bissau, specifically linked to developments associated with the end of the slave trade and rise of legitimate commerce (see below).

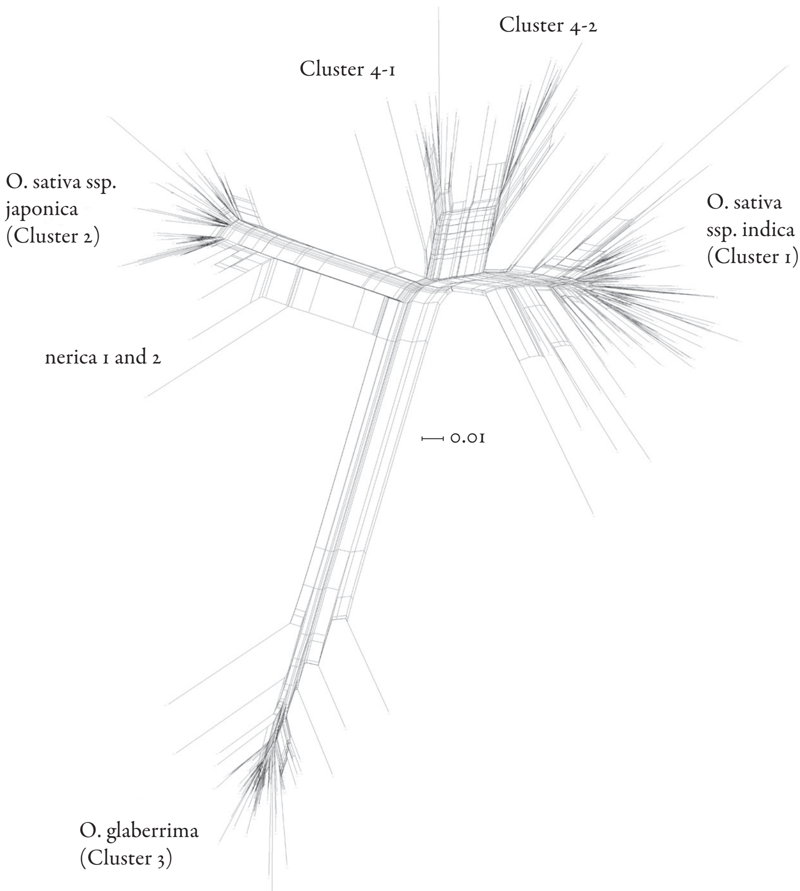


Figure 1. Phylogenetic relationships of 315 samples of rice collected in West Africa.

A mechanism for hybridization under farmer conditions has been proposed, based on detailed technographic observations in farmer fields. Rices of the two species flower together either when planted as deliberate mixtures (a practice farmers say they deploy in order to induce change) or when seed samples become mixed. Some African rice types linger in farms mainly planted to Asian rice as weedy off-types. Pollen exchange takes place among co-flowering African and Asian rice plants produces (Figure 2). The F1 plants flower but produce little or no seed. Flowering allows back-crossing on to one or other parent plant, if the parent type lingers in the field as a ratoon or is replanted or regenerated in a farm site used for two years in succession. It is from this point that fertility is restored, and the farmer's keen eye detects interesting off-types. These off-types are often planted close to farm huts as experiments, to see if they bring any benefits. It is from these samples that stable hybrid-derived types emerge, to be distributed informally farmer-to-farmer.

Work is on-going on the properties of these farmer hybrids, but field information indicates they may have superior weed competitive properties, out-yielding introduced types on farms with poor soils. They may also have preferred grain characteristics and better nutritional properties. A number are widespread in their immediate regions of presumed origin (Sierra Leone and Guinea Bissau).

The localization of hybrid-derived rices in West Africa probably reflects historical conditions. Commercialization of rice production was stimulated in coastal West Africa by the Atlantic slave trade. The main rices feeding the slaves ships and coastal trading settlements were undoubtedly red-skinned African types. Slave dealers and traders frequently commented on the fact. By the 1820s, however, traders from Freetown were "pushing" Asian white rice along the rivers to the north of the infant colony.[1] The new settlement had begun to export rice to Europe, where (according to contemporary documentation) only white types were acceptable.

[1] I thank Professor Bruce Mouser for generously sharing with me items relating to the early development of white rice on the West African coast north of Sierra Leone between 1821 and 1824 compiled from files in the British Public Record Office (PRO, Colonial Office, Series 271, volumes 1 and 2). I am also grateful for access to his unpublished notes telling the story of Amara, Almamy of Moria from 1802 to 1826.

In 1821 a group of Susu farmers from an inland town on the Great Scarcies river grew enough white rice to supply six canoe loads to Freetown, but the canoes were stopped by the local ruler, Amara of Moria. Amara was linked to the slave trade, and opposed to Freetown influence. Amara saw no need to grow white rice since the normal diet of local people sold into captivity was red rice. The British then moved to lift Amara's blockade, and carefully articulated for his benefit the case for producing white rice for export.

Figure 2. Two rice species flowering together.

The nub of this story is that along the Scarcies valley and adjacent rivers, where many hybrid types are now found, the two species were actively promoted as rival commercial types in the early 19th century. West African rice plantation owners will doubtless have ordered the roguing of types intended for the export market, to keep the white and red rices separate.

Experimental data show that in-field out-crossing is much higher in rice than between-field out-crossing (Nuijten & Richards 2010, in preparation). The tendency towards hybridization will probably have been most rapidly advanced on the small subsistence plots of slaves, or on the equally small farms of the subsistence-oriented peasants in the aftermath of abolition. From recurrent on-farm mixing and spontaneous back-crossing guided by farmer keen-eyed observation and selection – a type of "skill oriented precision farming" linking rice farmers across the globe – new West African hybrid types eventually emerged, a small triumph for food security over the agrarian social adversity of the times.

In 2004 the World Food Prize was awarded to Green Revolution researchers for the development of stable inter-specific hybrid rices produced by back-crossing African rice on to Asian rice – the Nerica series. This award has the welcome implication of endorsing the intrinsic significance of earlier efforts by West African farmers to select and disseminate their own inter-specific hybrid rices. Working out what properties make farmer hybrids attractive should now be a starting point for future food security research on rice in Africa. Farmer precision agriculture is a legacy of technical knowledge too important to ignore. And yet those who plan the investment of the money now pledged to global food security research still prefer to start from where they find themselves, on high, rather than seeking first the position and perspective of the poor. A re-think is needed.

This brings me to some concluding thoughts about building a different kind of Green Revolution based on localised technical and social partnerships between engineers and food-insecure communities. Instead of funding remote centres of excellence, in the hope that technologies will spread, the call here is to work directly where the problem is found, and directly with the people who own the problem, through mobilizing their own potential to act as engineers and designers

. . .

of food security solutions. The aim is to shift perspectives on technology generation from ex situ engineering towards management of emergent properties of well-configured decentralised socio-technical systems (Richards et al., 2009). Any such shift offers a fundamental challenge to our own international centre of excellence affecting both its research and education mission (Kibwika 2006). If – in a world of top-down institutions, top-down grants and top-down assessment – a proposal for People's Science is now seriously debated I will have fulfilled my mission in Wageningen over the past 17 years. I have four points to make.

1. Build partnerships around tasks and task groups. Action is the key to advance. India is an especially good example of a country in which civil society support groups and small-scale NGOs have contributed much to the documentation and protection of discoveries made by farmers and farm labourers. Better partnerships are needed between these interested parties and formal science. We hope that our own recently funded NWO initiative with Indian partners around the system of rice intensification will prove to be a model for how to integrate farmer discovery, the energy and the power of civil society movements and the analytical rigour of contemporary science and technology, better to support an agenda of agrarian research and development starting from needs and tendencies at grass roots.

2. Support decentralised crop development partnerships. A lead here is provided by the work of a former TAD PhD student, Dr Song Yiching in China. Her aim, based on what she found in research on localised maize seed systems (Song 1998) was to show that a research-oriented support nexus could be created by forging connections between local research station staff and women's farming groups for specialist seed production. With her involvement in a new project in China we hope now to explore some of the ways in which these local seed system dynamics can be further strengthened in the field of rice.

3. Experiment with unsupervised learning. Soft-ware engineers recognise two kinds of artificial neural networks – ones in which a network is trained to recognise certain patterns (supervised learning) and one in which pattern recognition comes from massive selection and feedback (unsupervised learning). It has been suggested that this might provide a useful analogy for some of the processes involved in attaining greater food security among a large and scattered population of impoverished farmers (Richards et al., 2009). For example, different seeds – local and improved – might be introduced into a network of farmers at random, with distributional pattern being attained solely through farmer-to-farmer distribution and feedback (it might first be necessary to check how participants were in fact networked – e.g. via marriage or a cell phone network; the experiment might not work among a population of true social isolates). Experiments of this sort have produced interesting results in terms of computer access and uptake among ghetto dwelling youth (Mitra 2005). One of the problems with top-down technology development processes is the enormous effort and expense required for dissemination, further complicated by the many points at which breakdowns or bottlenecks occur, including opportunities for rent-seeking behaviour. Here, a historical perspective is helpful in reminding us that there are systemic alternatives to a top-down Green Revolution. The spread of cassava throughout Africa in the days of the slave trade was entirely unsupervised. At least some modest percentage of the billions allegedly now pledged to solve the problem of world hunger should be devoted to well designed experiments in replicating such self-organized distributional successes.

4. Improve training and support facilities for a new Green Revolution from below. Partners in this great new venture in People's Science– including representatives of agrarian communities – will need a new, flexible, interdisciplinary curriculum, based on a mix of social and biological science analysis implicit in the decentralised technology development strategies outlined above. There is here a major challenge to Wageningen University not only to develop effective partnerships with universities in regions of greatest potential food insecurity but also to ensure that these partnerships link up in appropriate ways with new kinds of grass roots partners, such as civil society groups, environmental campaigning groups, and farmer and farm-labourer organizations. The levelling of this particular playing field in science and technology development, and debate about what must be built upon it, is a topic beyond the scope of a farewell lecture. It is something to which I hope to devote new found energy in retirement. But suffice it to say that inter-personal networks are also very important, an area in which the group I am now leaving has invested heavily. We have made a small, but significant start, with assistance from a range of donors, including the Rockefeller Foundation, in training PhD students with backgrounds in, and continuing commitments to, some of the grass-roots organizations, but capable of interacting on a basis of equality with scientists, technicians and engineers. It is my hope that Wageningen University will continue to support this trend.

It remains only to offer some thanks. I will not (with one exception) name names because there are too many. First and foremost I thank my colleagues and students for the contributions they have unstintingly made to the objectives described above. Second I thank my children and extended family in Netherlands, the United Kingdom and Sierra Leone, for love, support and tolerance of my preoccupation with work. Third, I thank the many colleagues in different groups in Wageningen who have offered cooperation and friendship over the past 17 years. Our numerous joint publications remain a record of collaborations that have been as simulating and enjoyable as they have been productive. Fourth, I thank the Rector and his administrative staff for their devotion to the task of keeping the university responsive to new opportunities in difficult times. Professors must at times seem creatures of tunnel vision, so I thank the university administration for their generous efforts in making it possible for us to stare so intently. I mention by name, and inscribe this lecture to Esther Mokuwa, my wife, currently supervising a large field data collection team in the Gola Forest, but who indelibly accompanied the drafting of this talk with thunderous blows into her *mata-odo* (wooden mortar), not (you must understand) for my dinner, but as part of an experiment into how much pericarp is removed when *Oryza glaberrima* is cleaned. For such selfless devotion to food security (and everything else besides) mere thanks are not enough. Finally I thank you all for coming, and most especially those who travelled from far. I leave you with the fact that this talk is 25% shorter than my inaugural address. I view this both as a measure of what our group has so far achieved, and what yet remains to be done. With that challenging thought I will now fall silent, and wish you farewell.

References

Barrow, L., 1986. *Independent spirits: spiritualism and the English plebeians*, London: Routledge.

Bray, F., 1986. *The rice economies: technology and development in Asian societies*, Oxford: Blackwell.

Dant, T., 2005. *Materiality and society*, Maidenhead: Open University Press

Durkheim, E., 1995 [1912]. *The elementary forms of religious life*. New York: Free Press (trans. Karen E. Fields).

Henrich, J., et al., 2004. *Foundations of human sociality: economic experiments and ethnographic evidence from fifteen small-scale societies*, Oxford: Oxford University Press.

Kibwika, P., 2006. *Learning to make change: developing innovation comepetence for re-creating the African university of the 21st century*, Wageningen: Wageningen Academic Publishers.

Mallet, J., 2005. Hybridization as invasion of the genome, *Trends in Ecology and Evolution* 20, 229-237.

Mallet, J., 2007. Hybrid speciation, *Nature* v 446, 15 March 2007 doi:10.1038/nature05706.

Mauss, M., 1936. Les techniques du corps, *Journal de Psychologie* 32 (3-4) (communication presented to the Society for Psychology, 17th May 1934, English translation, *Economy and Society* 2(1), 70-88, 1973).

McFeat, T., 1972. *Small-group cultures*. Oxford & New York: Pergamon

Mitra, S., 2005. Self-organizing systems for mass computer literacy: findings from the 'hole in the wall' experiments, *International Journal of Development Issues* 4(1), 71-81.

Nuijten, E and Richards, P., 2010. Pollen flows within and between rice fields in relation to farmer variety development in The Gambia (submitted).

Nuijten E., Van Treuren R., Struik PC., Mokuwa A., Okry F., Teeken B and Richards P., 2009. Evidence for the emergence of new rice types of interspecific hybrid origin in West-African farmer fields. *PLoS ONE* 4(10): e7335. doi:10.1371/journal.pone.0007335.

Offei, SK., Crane, T., Hughes, SG., Mokuwa, A., Nuijten, E., Okry, F., Struik, PC., Teeken, B., & Richards, P., 2009. Making better seeds for African food security: a new approach to scientist-farmer partnerships, *Aspects of Applied Biology* 96, 141-148.

Perkins, J., 1997. *Geopolitics and the Green Revolution: wheat, genes and the Cold War*, Oxford: Oxford University Press.

Richards, P., 1985. *Indigenous Agricultural Revolution: ecology and food production in West Africa*. London: Hutchinson.

Richards, P., 1989. Farmers also experiment: a neglected intellectual resource in African science, *Discovery & Innovation* 1(1), 19-25.

Richards, P., De Bruin-Hoekzema, M., Hughes, SG., Kudadjie-Freeman, C., Offei, SK., Struik, PC and Zannou, A., 2009. Seed systems for African food security: linking molecular genetic analysis and cultural knowledge in West Africa, *International Journal of Technology Management* 45, 196-214.

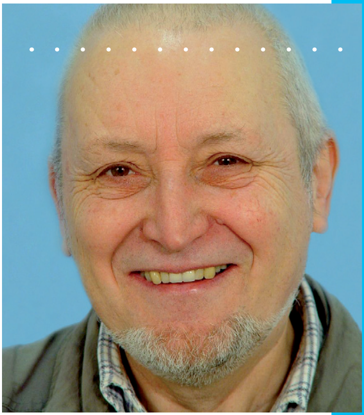
Schlanger, N., (ed.) 2006. *Marcel Mauss: techniques, technology and civilization* (edited with an introduction ny Nathan Schlanger), New York & Oxford: Durkheim Press/Berghahn Books.

Selin, H., (ed.) 1997. Encyclopedia of the History of Science, Technology and Medicine in Non-Western Cultures, Dordrecht: Kluwer.

Shen, Xiaobai 2010, Understanding the evolution of rice technology in China: from traditional agriculture to GM rice today, Journal of Development Studies 46(6), 1026-1046.

Song, Yiching, 1998. *"New" seed in "old" China*. PhD Thesis, Wageningen University.

Suchman, L., 1987. *Plans and situated actions: the problem of human-machine interaction*, Cambridge: Cambridge University Press.



The world is determined to reduce hunger and poverty. Agro-technology has to play a key part. This talk poses a fundamental question about the nature of agro-technology. Heroic external interventions in farming are often far from sustainable. Farming husbands biological resources, and biological resources are subject to evolution. Is there a case for going with the (evolutionary) flow? The study of farmer seed selection leads to surprising results. Farmers are effective agents of hybridity. Maybe it is time to empower these agents of change directly?

ISBN 987-90-8585-885-0