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Reforming the Global Food and Agriculture System: Towards a Questioning Agenda for the New Manifesto

Erik Millstone, John Thompson, Sally Brooks

Agriculture

STEPS centre

About this paper

In the face of the pressing challenges posed by hunger, malnutrition and the vulnerability of our food system, it is imperative that radical reforms to the food system are articulated and implemented. Questions about the governance of the current food system need to be posed and answered. Key issues that need to be addressed include the direction of innovation and technological choices, the distribution of costs and benefits amongst producers, consumers and our environment, and the diversity and characteristics of possible socio-technical pathways that could be lead to more sustainable and socially just food futures. This paper presents some ideas on what a comprehensive strategy for reforming the global food and agriculture system might look like, in light of those questions about directionality, distribution and diversity.

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About the Manifesto project

In 1970 a radical document called The Sussex Manifesto helped shape modern thinking on science and technology for development. Forty years on, we live in a highly globalised, interconnected and yet privatised world. We have witnessed unprecedented advances in science and technology, the rise of Asia and ever-shifting patterns of inequality. What kind of science and technology for development Manifesto is needed for today's world? The STEPS Centre is creating a new manifesto with one of the authors of the original, Professor Geoff Oldham. Seeking to bring cutting-edge ideas and some Southern perspectives to current policy, the New Manifesto will recommend new ways of linking science and innovation to development for a more sustainable, equitable and resilient future.

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About the STEPS Centre

The STEPS Centre (Social, Technological and Environmental Pathways to Sustainability) is an interdisciplinary global research and policy engagement hub that unites development studies with science and technology studies. Based at the Institute of Development Studies and SPRU Science and Technology Policy Research at the University of Sussex, with partners in Africa, Asia and Latin America, we are funded by the Economic and Social Research Council.

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This is one of a series of Working Papers from the STEPS Centre
www.steps-centre.org

ISBN: 978 1 85864 783 5

IDS Institute of Development Studies
US University of Sussex
SPRU – Science & Technology Policy Research
E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL

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Correct citation: Millstone, E., Thompson, J. and Brooks, S. (2009) *Reforming the Global Food and Agriculture System: Towards a Questioning Agenda for the New Manifesto*, STEPS Working Paper 26, Brighton: STEPS Centre

First published in 2009

ISBN 978 1 85864 783 5

Thanks to Elisa Arond and Harriet Le Bris for help with copy-editing.

Cover design by Barney Haward.

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INTRODUCTION

The New Manifesto process provides an opportunity critically to analyse and to reassess the global food and agricultural system in the light of growing uncertainties. In the face of the pressing challenges posed by hunger, malnutrition and the vulnerability of our food system, it is imperative that radical reforms to our food system are articulated and implemented. Questions about the governance of the current food system need to be posed and answered. Key issues that need to be addressed include the direction of innovation and technological choices, the distribution of costs and benefits amongst producers, consumers and our environment, and the diversity and characteristics of possible socio-technical pathways that could lead to more sustainable and socially just food futures. This paper presents some ideas on what a comprehensive strategy for reforming the global food and agriculture system might look like, in light of those questions about directionality, distribution and diversity.

ADDRESSING DIRECTIONALITY, DISTRIBUTION AND DIVERSITY IN THE GLOBAL AGRI-FOOD SYSTEM

The food and agriculture sector is in some important ways quite unlike those of other sectors such as resource extraction, manufacturing or services. The demand for many types of goods and services can be very price elastic. Demand for staple foods, on the other hand, is notoriously price inelastic. If the prices of staple foods rise, people usually forgo luxuries to keep eating, while if the price of staples halves, few people will double their intake of for, example, potatoes, bread or rice – as long as they were adequately fed in the first place. Supplies of perishable foodstuffs can moreover be highly variable, depending on the vagaries of weather, pests and diseases and other shocks and stresses. Consequently prices (in unregulated agricultural markets) can be chronically volatile. Those instabilities and the measures taken to mitigate them, at least in most industrialised countries though not in most developing countries, complicate the challenges facing farmers and policy-makers. Those instabilities and measures also complicate the factors influencing the development, diffusion and adoption of technological changes in agri-food systems. Thus, the geographical differences between Kansas and Kenya may be less significant for agricultural innovation than the differences in their respective food systems and the governance of science and technology within them.

Like non-agricultural sectors of the economy, however, issues about directionality, distribution and diversity arise in relation to the agri-food systems, although sometimes in distinctive ways (Stirling 2007; Stirling 2009). The ***direction*** of technological change in the food and agriculture sectors is intensely contested and deeply problematic (Lang and Heasman 2004; Vanloqueren and Baret 2009). Attention often focuses on the ***pace*** at which agricultural innovation occurs, often based on concerns that some competitors may innovate more rapidly than other firms or industries. There are also understandable preoccupations with the efficiencies with which invested resources (such as land, labour, capital and technology) yield positive outcomes, not least for national competitiveness. The metrics adopted to estimate the pace of change may be imprecise and contested, but they typically focus in a 'scalar' fashion in terms of 'more' or 'less' on some chosen scale, which might be cardinal, ordinal or even qualitative. Agricultural innovations, like those in other sectors, should more accurately be understood as 'vector' (rather than as 'scalar') forces. Technological trajectories are characterised by the crucial property of ***direction*** as well as just ***magnitude***. Debates about the direction of technological change are at least as important as those concerning the pace of change. Debates about the utility and acceptability of genetic manipulation have been especially heated, but even if those debates were entirely resolved or discounted, those concerning the impact on food security of the direction of broader current technological trajectories would remain.

Although the implications have often been neglected, it is important to appreciate that agricultural science and technology develop along path-dependent trajectories. The characteristics and orientation of those trajectories are not determined in a simple linear way, e.g. from less to more technologically advanced agricultural practices. Drivers of, and constraints on, technological trajectories typically arise from agro-ecological, socio-economic and other contextual factors. Historic contingencies also often play important roles. Once adopted, however, several forms of feedback can serve to reinforce (or undermine) the particular direction taken. Rather than restricting policy debate to questions about the pace, efficiency and consequences of proceeding in the direction taken, there is a need to give commensurate attention to choices about the direction to be taken, amongst alternatives. In relation to agricultural innovation, it is vital to ask not only 'how much?'; 'how fast?'; and 'when?' but also 'which way?'; 'what else?'; 'who says?' and 'why?'

Discussions about the ***distribution*** of resources (such as land), support, investments, benefits and costs of changes to agricultural technologies and practices are no less important or contentious than those concerning, for example, the energy sector where inequalities in access to energy resources are linked to access to political power. For years it was evidently problematic that the total quantities of food *per capita* produced annually in this world had risen more rapidly than population, yet hundreds of millions of poor people continued to suffer chronic under-nutrition. Those 'distributional' problems have now been complicated by the evidence indicating that the total number of overweight and obese people now exceeds the numbers suffering under-nutrition (Delpeuch et al 2009 pp 70-71). Too little food is evidently available to those that need it most, and most is supplied to those that need it least. Both the food systems and the agricultural policy systems are consequently distributionally perverse.

There are also active and important debates about whether the prevailing forms and levels of ***diversity*** (whether in crop or livestock gene pools or other technologies and practices) are increasing or diminishing, and those issues are important for the resilience, robustness and security of agricultural and food systems. In the UK and EU those debates are often couched in official circles in terms of 'food security'. In a world of increasing globalisation and standardisation, diversity could provide a valuable means to preserve crucial context-dependent sensitivities – whether these are agroecological, socio-cultural or technological. Since the interests of the least powerful are *ipso facto* most marginalised, the opening of wider ranges of possible pathways through diversification may correspondingly tend (on balance) to be beneficial to those who are otherwise poorly resourced and supported. Where uncertainties are acknowledged to be at least partly intractable to conventional analysis, diversity can provide a vital means to ensure that 'not all the eggs are in one basket'.

From detailed studies of technological change in agri-food systems, it is increasingly clear that a diversity of inter-dependent artefacts, creative and integrated practices and flexible institutions play important roles in fostering more robust forms of innovation (Thompson & Scoones 2009). Where (as is often the case) plural societies find themselves unable to arrive at consensus over the most appropriate course for innovation or development, diversity can present a unique means to accommodate otherwise irreconcilable perspectives. The dynamic forces that drive processes of concentration of ownership as well as benefits and costs can be reinforced by 'locking-in' patterns of agricultural development and innovation. As conditions change, and changes become more uncertain and so less predictable, there is an increasingly important role for the pursuit of 'deliberate diversification'.

The following discussion highlights these themes of directionality, distribution and diversity while reviewing some of the important characteristics of, and challenges confronting, the future of agri-food systems.

FOOD AND AGRICULTURE – PERVERSE TRENDS IN A DISTINCTIVE SECTOR

Globally, the food and agricultural sector is polarised and the structure and operations of the systems through which people obtain, or fail to obtain, nutritious and safe food supplies are perverse in many respects. This document will not review or even list all of those perversities, but will focus on a few of the system's most important features.

Firstly, the political economy of the global agri-food system is perverse because it provides most help to those who need it least and least to those who need it most. The governments of most wealthy industrialised countries have, since the end of the Second World War, been providing financial and regulatory support to their agricultural enterprises. One key element of that support has been the adoption of sets of policies that have provided 'floors' and 'ceilings' to agricultural prices to limit the range within which they can fluctuate. Those measures have stabilised what would otherwise have been volatile markets, and ensured that their domestic consumers had reliable supplies of food at affordable prices and that farmers received income levels deemed sufficient. However, those practices have also imposed adverse consequences on farmers in poor countries. The EU, USA and other wealthy countries impose tariffs, and various non-tariff barriers, to restrict imports of foods that are produced in their domestic markets. They do not impose tariffs on tropical products that they cannot produce, such as tea and coffee, but tariffs protect domestic producers against foreign competition. Since the USA and EU also subsidise exports of their surplus agricultural commodities, they harm farmers in poor countries with both sets of measures.

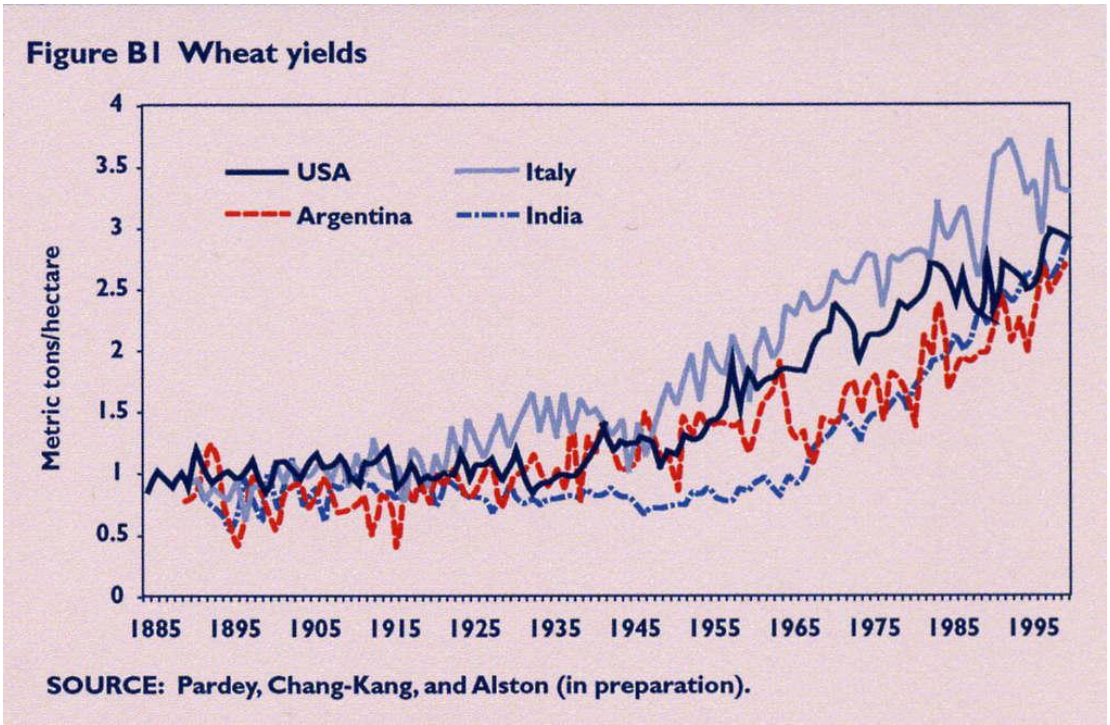
A second key feature of the prevailing global agricultural regime has been substantial expenditure on agricultural scientific and technological research and development (R&D). Those investments have been designed to drive down production costs and to increase the productivity of land and labour. The impacts of those investments were reinforced by the provision of education and training to farmers and by extension services that performed two critical functions. They not only provided farmers, in the industrialised countries, with technical information and access to new products and services, they also gathered information and understanding from farmers about their technical and commercial problems, and then transmitted that information back to the institutions and individuals responsible for agricultural R&D. Through those mechanisms, farmers could have an input into setting the agenda for agricultural R&D (Jones and Garforth 1997; Klerkx et al 2009). The protection afforded to farmers in the industrialised countries has contrasted sharply with the lack of corresponding support to poor farmers in developing countries. In aggregate and on average, those in most need receive least support.

The investments in the agricultural sectors of the industrialised countries paid off handsomely for many, though not all, farmers and tolerably well for most consumers in those wealthy countries, but many of them caused serious damage to agriculture in many poor developing countries. Scientific and technological research and development funded by governments and firms in the agriculture machinery, agrochemicals and plant and animal breeding industries have produced rapid and sustained improvements in the productivity of land, labour plants and animals. One important consequence of the implementation of those regulatory and innovation policies has been a growing concentration in the ownership and control of, for example land, as well as the trade, processing and retail of agricultural commodities and food products. The dynamics of concentration have often aggravated the symptoms, while inhibiting competition and processes of reform.

The productivity of industrialised agriculture is now so high, and subsidies so long-lasting and generous that poor farmers can rarely compete in globalised markets, even though the cost of their agricultural labour is so low. On the other hand, it would be a mistake to assume that technological change in agriculture had made the productivity of agriculture more predictable. As the graphic illustration in Figure 1, below, indicates, over time since the 1880s the volatility of wheat yields has increased rather

than diminished, and those volatilities have been highest in some of the countries where the rates of technological change have been particularly rapid.

FIGURE 1: WHEAT YIELDS, METRIC TONNES/HECTARE: 1885-1995



The suggestion that technological change has provided security of supplies and consequently ensures market stabilisation, and therefore that public policy interventions to stabilise markets have become redundant, is not persuasive.

To compound the perversity, the hyper-productivity of industrialised farming has driven a process that has resulted in what the WHO has coyly referred to as 'hyper-alimentation', or over-eating (WHO 2007). The incidence of diet-related pathologies such as obesity, type-2 diabetes and cancer have been rising rapidly in the industrialised countries, but more recently has also been increasingly conspicuous in the global South. Ironically, in Kenya '...[b]etween 1969 and 1999, the production of green vegetables more than doubled...and exports were up by 6 per cent. Most of these exports are destined for the British market, under the control of the major supermarkets...during the same period the consumption of green vegetables [in Kenya] fell by almost 30%' (Delpeuch et al 2009). Over-eating and under-nutrition can consequently often be two sides of the same coin.

Since 1945, the experiences in the agricultural sectors of poor developing countries have been radically different from those in the 'global North'. In Africa, for example, during the colonial era governments often provided economic and technological support and extension services to their (white) commercial farmers, but virtually none to (black) subsistence farmers. In the post-colonial era, many governments initially tried to provide support in the form of price stabilisation measures, and extension services, but the focus was more often on producing cash crops for export rather than food crops for domestic consumption. Most frequently support for those export crops went to the large and relatively affluent farmers and land-owners, rather than to the poorest or hungriest. African governments never devoted adequate resources to the development of technologies that would be primarily appropriate for

subsistence farmers. Often their focus has been on supporting the production of cash crops, such as coffee, cocoa and tobacco in the hope of generating export income with which to pay for food imports. Often developing countries borrowed funds for their investments, and for their expenditures.

The burden of accumulated debt created the conditions under which the 'Washington Consensus' was imposed in the 1980s and 1990s, which entailed dismantling residual African publicly-supported agricultural extension services, except for those delivering cash crops for affluent consumers. While agricultural subsidies have been officially deemed essential in the industrialised countries, they have been deemed inappropriate and unacceptable in developing countries. One consequence has been that the poor and the weak have endured far greater food price volatilities than have been experienced in for example the EU or USA. Domestic policy regimes in many developing countries have also been characterised by what Michael Lipton called an 'urban bias', based on the assumption that development would be a linear process of transformation from the rural and agricultural towards the urban and industrial, through rapid resource transfers from village to city (Lipton 1976). In 1976 Lipton argued that the 60 to 80 percent of people in poor countries who depended on agriculture for their livelihoods were typically allocated less than 20 percent of development spending (Lipton 1976). Urban areas continue to get a disproportionate share of public spending and poor people in rural areas are often disadvantaged in terms of nutrition, education, health, technology and access to financial services (Eastwood and Lipton 2000; Bezemer and Headey 2008; Kay 2009). Government policies keep goods and services from rural areas (for example, food) under-priced and those from urban areas over-priced. Urban bias has resulted in a rural skills drain as educated younger workers leave to work in towns and cities and prevented the formation of valuable rural-urban links. As a result, the gap between urban and rural wealth and power is much bigger in many poor countries than it was historically in rich countries during the early stages of their development.

This urban bias, reinforced by two decades of globalisation, trade liberalisation and market concentration, has created and sustained two very different food systems, which mirror the tensions that are causing a rapid divergence between and within rural communities in both developing and industrialised regions. A minority of the rural population is connected to the global agri-food economy through contracts with agribusiness and even directly with supermarkets. The other extreme is a world marked by the struggle for food security and survival, of livelihoods fractured into diverse mixtures of off-farm work, temporary migration and subsistence agriculture against a backdrop of deteriorating human and natural resources. In between is a 'shrinking middle' of family farmers and landed peasants producing undifferentiated commodities with low and declining returns. This process of rural differentiation is underway in both the North and the South.

In recent years, increasing concern has also been expressed about what its detractors refer to as a modern day 'land grab'. For example, Hafiz has complained that '...the acquisition of farm land from the world's poor by rich countries and international corporations is accelerating at an alarming rate' (Hafiz 2009). Those arrangements concentrate land ownership in the hands of those who already have significant wealth, and take it from those who are already on the margins. The challenge of agrarian 'land reform' has often been understood as the task of providing the landless and the land-poor with improved access to more rather than less land, so the international transfer of ownership of agricultural land to wealthy countries and corporations from poor citizens and countries might be counted as yet a further perversity.

There is enormous scope for improving the livelihoods of poor farmers and farm workers by developing and disseminating improved technologies, but the rural poor will only benefit from those efforts if the perversity of providing most support to those who need it least and least to those who need it most is consciously countered. Agricultural price stabilisation, for example, will be no less important in poor countries than in those that are industrialised. Many of the poor people in poor countries would be much

better off if the balance of public support shifted from rich farmers in rich countries in favour of poor farmers in poor countries, with locally-appropriate agricultural price and supply stabilisation regimes for both rich and poor farmers, consumers and countries.

The prevailing regime and the resulting *status quo* were not set by transparent and accountable institutions and processes. As Heffernan and colleagues have observed, the increasingly centralised and undemocratic agri-food system that has been created through perverse public policy decisions and corporate actions were '...never voted on by...the people of the world. It is the product of deliberate decisions made by a very few powerful human actors. This is not the only system that could emerge. Is it not time to ask some critical questions about our food system and about what is in the best interest of this and future generations?' (Heffernan et al 1999)

One key to reducing the perversity of the current food system could be by ensuring that the global agricultural policy regime was reformed in and by transparent and accountable processes and institutions. Since women make up the vast majority of small holders and subsistence farmers and grow the majority of the world's food, accountability to them will be critical. If the predicaments of poor farmers in poor countries, and of those who rely on agricultural employment for significant fractions of their livelihoods are to be improved, it will be necessary radically to transform patterns of resource allocation.

The aspirations of philanthropic donors such as the Bill & Melinda Gates Foundation to solve the problems of the rural poor in the Global South by developing smart new high technology products for them, and then disseminating them through liberalised markets, may well be ineffective, particularly in the more complex, diverse, risk prone areas. Chronic hunger is not primarily a technological problem, and the chronically poor cannot readily trade their way out of poverty (Hunger Task Force 2008). Poverty is primarily an economic, social and political problem with structural roots that can not be addressed through technological innovation alone. In most cases, technological changes without socio-economic changes will at best be ineffectual or at worse counter-productive.

REFORMING THE GLOBAL AGRICULTURAL RESEARCH SYSTEM

The Rockefeller and Ford Foundations established a set of international agricultural research centres in the 1940s (such as the International Rice Research Institute – IRRI, and the International Maize and Wheat Improvement Center – CIMMYT). Subsequently governments of industrialised countries, as well as the institutions they support such as the World Bank, and even more recently the Gates Foundation, have devoted considerable research and development resources to (what they have assumed to be) the technological needs of agriculture in developing countries by investing heavily in the small number of large research bodies that have operated under the aegis of the Consultative Group on International Agricultural Research (or CGIAR) system (including IRRI and CIMMYT).[1] The CGIAR centres see one of their key roles as delivering germplasm for seeds with improved characteristics to a network of so-calls 'NARS' or National Agricultural Research Systems.

In 2004, the CGIAR centres had an annual operating budget of ~$440m, by comparison with total public expenditure on agricultural R&D by 'developing countries', including China, of some $12,800m. However, the CGIAR centres together accounted for some 34% of all public agricultural R&D expenditures for

[1] CGIAR now has 64 governmental and non-governmental members and 15 research centres, working in collaboration with hundreds of government and civil society organisations as well as private businesses. CGIAR members include 21 developing and 26 industrialised countries, four co-sponsors (World Ban, IFAD, FAO and UNDP) as well as 13 other international organisations. Today, more than 8,000 CGIAR scientists and staff are active in over 100 countries throughout the world. See http://www.cgiar.org/ (accessed 11 June 2009)

developing countries (Pardey et al 2006 p 19 and p 313). A question remains as to whether, despite these substantial resources, the investments into the CGIAR institutions have adequately benefitted poor farmers or helped to solve their problems. The CGIAR centres have developed technologies that have been adopted by many commercial farmers, some of whom have been relatively poor, but there remains a vigorous debate on whether or not they have managed to reach subsistence farmers, especially in Africa, or to have benefitted the landless rural poor who depend for much of their livelihoods on wages for agricultural labour.

The Asian Green Revolution of the 1970s and 1980s, which depended heavily on R&D at CGIAR institutions and on effective publicly-funded extension services for the diffusion and adoption of the seeds and agronomic techniques, delivered in aggregate substantially increased production. However, in the Punjab and the Philippines, for example, the introduction of Green Revolution varieties amplified the prevailing inequalities, and drove the poorest off what little land they may have had, and often out of rural livelihoods altogether into rapidly growing urban slums. On the other hand in for example, the Indian state of Kerala and in Formosa/Taiwan where the distribution of land ownership was far more equitable, the effects of the new technology were more beneficial and widespread (Griffin 1974). Those contrasting examples illustrate the crucial influence of the socio-economic contexts into which technologies are introduced in determining the character and distribution of impacts. Inappropriate technologies can amplify social and economic inequalities rather than diminish them, and aggravate rather than diminish poverty (Junankar 1978; Lipton and Longhurst 1989; Hazell and Ramasamy1991; Lappé et al 1998).

Some of the research teams at CGIAR institutions have shown a rather limited understanding of the predicaments of the poor farmers whose interest they should be serving. While individual scientists are often aware of the diversity and complexity of the social and agro-ecological conditions for which they develop technologies, framing assumptions embedded in the culture of scientific institutions tend to narrow the range of possible ways in which problems and their solutions can be defined and addressed. As a result, poor farmers' decisions and practices are often misunderstood or over-simplified; they are too often assumed to be rudimentary entrepreneurs seeking opportunities for profitable, if risky, investments. Frequently, however, poor farmers need to avoid risks because they have so little to spend and even less to invest. While some CGIAR scientists have employed approaches such as participatory plant breeding, client-oriented breeding and participatory varietal selection to address the needs of poor farmers, most are under institutional and disciplinary pressures to treat, for example, the challenge of plant breeding as if just a few agronomic variables could be addressed in isolation from the complexities of socio-economic contexts in which farmers operate beyond the boundaries of research institutions.

In Africa, the innovations coming from the CGIAR institutes have sometimes been adopted, but almost entirely by commercial farmers, including some that are relatively poor, rather than by subsistence farmers. Often those technological innovations have been labour-saving rather than employment-generating, so their adoption can adversely affect those who are dependent on agricultural employment.

The perspectives of subsistence farmers and landless agricultural labourers are very different from those of commercial farmers or of some CGIAR researchers. Poor farmers, such as those growing maize in Ghana and Eastern Kenya, rarely buy certified commercial seeds. They have too little capital, and no access to suitable credit. Instead they save, select, exchange, beg and borrow seeds, rather than buy them. Buying seeds can look very unattractive to them, too expensive and too risky. In practice, those farmers do possess relevant knowledge, and their knowledge and capabilities need to be engaged if appropriate innovations are to be developed, adopted and sustained. Research institutions also too often neglect the importance of supporting the development of technological capabilities amongst the anticipated recipients and beneficiaries of those technologies. In the absence of those capabilities, innovations will either not be adopted or adopted ineffectually or be discarded entirely.

If poor African farmers are to benefit from technological innovations, and become sustainably innovative, it will be necessary to re-configure the research system, transforming that system into one that is far more accountable to its intended beneficiaries, and conducted in more widely dispersed locations and engaging a wider range of stakeholders. What accountability there is at the moment is almost entirely upwards, to those providing the funding, but not downwards, to representatives of the intended beneficiaries.

Technological research and development agendas should therefore be reframed by reference to the needs, capabilities and aspirations of farmers, rather than by the technological opportunities for, and enthusiasms of, the researchers or by the corporate strategies of agrichemical, biotechnology or seed supply firms. Moreover, without effective public and low-cost private extension services, which would mediate two-way communication between farmers and researchers, the appropriate technologies and associated competencies, will be neither developed nor utilised.

The recent return of agriculture – and in particular science and technology for agriculture – to the international donor agenda therefore presents an opportunity to address these issues. Thus far, however, the resources of both traditional donors and new philanthropists such as the BMGF are consolidating rather than challenging the arrangements outlined above and the assumptions on which they are based. Emphasising a return to upstream research and the potential of generic, 'silver bullet' solutions that emerge from such research to achieve 'impact at scale', these donors are directing a return to large-scale, 'big science' programmes that, they hope, will reinvigorate African agriculture (Brooks et al 2009). What is needed, they argue, is a 'Green Revolution for Africa'. (AGRA 2009) An ambitious Programme for African Seed Systems (PASS) aims to make commercial varieties more widely available, with private 'agro-dealers' acting as a *de facto* extension service (PASS 2009). Furthermore, the approaches adopted by AGRA and PASS assume that the challenges and uncertainties confronting African farmers in the face of climate change can best be addressed through large scale investments in highly centralised crop improvement programmes (DTMA 2009; AATF 2009).

Subsistence farmers, however, have very different needs and interests from commercial farmers. Seeds that are either patent-protected or hybrids, which preclude or discourage seed saving in favour of repeated annual purchases, are not appropriate to Africa's poor farmers. The output of the CGIAR institutes and NARs focuses on seeds that can be formally certified as uniform, distinct and stable while subsistence farmers benefit from diversity, variability and flexibility to provide them with insurance against, for example, climatic or economic risks (Smale et al 2008). Seeds that retain more moisture and so are vulnerable to toxigenic fungi (eg mycotoxins, such as aflatoxins) and store poorly may also be inappropriate for poor farmers that do not possess the facilities for drying or dry storage. (Munkvold 2003). Seeds that only perform well if supplemented by other costly inputs, such as irrigation, fertilisers and herbicides, are also inappropriate unless those other inputs were also readily available and affordable.

The problems of climate-driven uncertainty have important implications for expectations concerning the weather, water supplies and the possible increased severity of droughts and floods, all of which would affect food production especially in vulnerable subsistence sectors. The threat posed by 'climate change' should not be confused, however, simply with 'global warming'. Climate change results from more energetic weather systems, which in turn imply greater volatility rather than just warmer or drier seasons. Africa's rural poor therefore will have to try to cope with, and respond to, the increased uncertainty arising from the growing volatility of ecological and economic conditions. An accelerated warming trend may be combined with increased seasonal variability. Consequently African farmers (both poor and not so poor) may want seeds that can cope with more than just 'drought', and with meteorological shocks as well as stresses. Poor farmers can, moreover, often benefit more from

diversification than from intensification; intensification without diversification could increase rather than diminish their risks.

Some commentators argue that novel germplasm and plant varieties are 'scale neutral', by which they imply that planting the novel seeds can benefit poor farmers as well as those that are better off (Paarlberg 2008; AATF undated); but that claim is unconvincing, as the earlier discussion indicated, which compared the distribution of costs and benefits of the Green Revolution in the Philippines and in Taiwan, or in Kerala and the Punjab. Since the varieties will normally be available only as officially certified and commercially marketed seeds, even if they are no more expensive than other commercial seeds, they will be too costly for the vast majority of subsistence farmers in, for example, the dry lands of Eastern Kenya or northern Ghana. The farmers' returns on their investment in those seeds will also depend on the availability and costs of other inputs, such as irrigation, fertilizers, herbicides and pesticides, all of which are often beyond the reach of poor farmers. Commercial farmers can 'harvest' economies of scale from CGIAR-derived plant varieties at least as readily as they can from other commercial seeds; while those economies of scale are often inaccessible to poor farmers and landless labourers.

A 'farmer first' approach to setting agendas for agricultural R&D was initially proposed over 20 years ago (Chambers et al 1989). That approach assumes that agricultural R&D is far more likely to benefit poor farmers if representatives of those intended beneficiaries participate in setting the agenda for R&D staff and in stipulating the criteria by which innovations are to be judged. Despite numerous efforts to implement such an approach, the CGIAR institutions have struggled to work with it (Scoones and Thompson 1994). In most cases, farmer participatory research initiatives have only succeeded because they have been limited in scope and impact. The approach has been small-scale and local, adopted at the margins of the CGIAR system, but not systematically adopted in or promoted by most of the CG institutions. Some progress was made, however under the innovative CIMMYT-led African Maize Stress (AMS) project, which was a point of departure in two important respects (AMS 2009). Firstly, it departed from the convention of breeding for optimal environments and developed new methodologies for 'managed stress' conditions. Second, the research team employed a participatory varietal-evaluation methodology popularly known as 'mother-and-baby' trials. While falling short of the type of demand-led methodologies promoted by 'farmer first' advocates, this did incorporate a secondary stage of farmer participation to follow on-station research.

In practice, however, plant breeders often find even this limited form of participation in plant breeding research problematic. They complain that different farmers said different things, and individual farmers emphasised multiple and contrary criteria. Rather than persevering with the challenge of guiding their research projects by reference to several criteria, between which trade-offs may be needed, they retreated to their familiar technical competence, and focussed on breeding for particular single traits. Those approaches have often been combined with a suggestion that the task of incorporating the novel germplasm into locally adapted varieties should lie with the NARs. In the event, the arrival of large scale programmes such as the 'Drought-tolerant Maize for Africa' (DTMA) and 'Water-efficient Maize for Africa' (WEMA), with their upstream focus on developing generic technologies for 'mega environments', has provided an opportunity to diminish up-stream participation by intended beneficiaries, rather than encouraging researchers to persevere with participatory methodologies (Ashby 2009).

Agricultural innovation needs to be understood as more than just scientific and technological research. Agricultural innovations are accomplished in systems, and those systems involve multiple groups of stakeholders that include the R&D professionals and farmers, as well as funders and chains of intermediaries. This implies rather more than just a standard plea for greater 'farmer participation'. It acknowledges the value and indispensability of farmers' expertise and understandings for technological development and utilisation. It also acknowledges the importance of linking those elements into systems of learning and innovation that draw in multiple sources of knowledge and capabilities. Such

approaches have made, and will make, little headway however without the regeneration of public sector R&D systems, with a renewed commitment to poverty-reducing and livelihoods-enhancing technology research.

If the needs of poor farmers really are to top the agricultural policy agenda, a new 'politics of demand' may be required to help shape the direction of agricultural innovation systems. This will require a reshaping of the global R&D architecture to create agricultural innovation systems that will link public and NGO-supported research with delivery systems, as well as partnerships amongst multiple users and researchers, combining 'demand pull' with 'supply push'. It will also be important to develop capabilities to participate and learn in innovation systems, boosting the knowledge and capacities of farmers and their organisations to innovate and to influence innovative pathways. This will involve strengthening networks and alliances to support, capture and share lessons on farmer-led innovations, and transforming agricultural education and building the institutional infrastructure to make this happen, from local to global levels (Scoones and Thompson 2009). Few of those changes would be quick, easy or cheap but the long-term benefits would be substantial.

The world's agricultural R&D systems are not only under-resourced; they are also disconnected from processes supporting wider development. They face numerous institutional bottlenecks and political barriers and frequently lack substantial connections with, input from and accountability to, their intended beneficiaries. Those prerequisites were recognised in the integrated reform process that the CGIAR launched in Maputo in late 2008, which seeks to change its governance structure and reorient its priorities. An 'integrated reform proposal' of the CGIAR called for a 'Conference for Agricultural Research for Development (CARD), composed of a 'Consortium' of centres and a separate 'Fund' that allocates resources to a series of 'mega-programmes' (CGIAR 2008). This separation and clarification of roles presents a unique opportunity to address issues of downward as well as upward accountability. Rather than further centralising funding allocations, we argue that this is a unique opportunity to empower the governments and farmers of those developing countries the CGIAR purports to serve. The funds could be channelled through developing country governments, but only if those governments were accountable to their own poor farmers. Those coalitions of farmers and governments could allocate funding to CGIAR Centres in response to their national and local priorities. Regional 'mega-programmes' may yet be a way forward, but only if in response to a locally coordinated, collective request from below, rather than as an imposition from above.

Lessons from the recent International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD) reinforced those arguments and offer guidance on ways to create more diverse, resilient and robust agri-food systems, based on integrated practices and new partnerships (see http://www.agassessment.org/). Furthermore, the launch of the new series of Global Conferences on Agricultural Research for Development (GCARD), led by the Global Forum for Agricultural Research (GFAR), offers opportunities for refocusing on approaches that should help meet the needs of resource-poor producers and consumers for sufficient, affordable, healthy food supplies, and to harness agriculture as an engine of sustainable pro-poor growth. It should also more effectively embed agricultural research into development processes, with outputs that would be accessible and relevant to poor people. By building on those efforts, the international community could potentially catalyse the much-needed transformations in the global agricultural research system and establish effective and integrated systems that could deliver the development impacts required, but not without a fundamental and far-reaching commitment to improving the governance of agricultural science, technology and innovation at all levels.

RETHINKING FOOD SAFETY REGULATION

The current global food safety regulatory regime developed by the Codex Alimentarius Commission, under the auspices of the WTO, has been designed to cater for those engaged in international trade in agricultural and food products; it is a club of countries and companies that have joint interests in setting minimum food safety standards for their own protection and, to a lesser extent, for their customers (Avery et al 1993). That regime however fails to take steps to help the global South provide higher standards domestically, just for exports. The voices of poor farmers are not heard at Codex because the poor countries negotiate on behalf of their export-oriented traders, not their domestic sectors. Consumer representation also occurs in only 'homeopathic doses', and is rarely influential.

Rather than a uniform set of global standards, set to suit the needs of the international food trade, poor farmers and consumers in developing countries would benefit from a more disaggregated and layered system, which differentiated market segments or regions, and allowed Sub-Saharan African, Latin American, European, G77 or North American countries to trade amongst themselves on their own chosen basis. A significant dilemma arises in this context however. On the one hand, there could be greater opportunities for trade amongst developing countries if they had different standards from those that apply in the USA, the EU or Japan. On the other hand, if there were multiple sets of standards at different levels, that might serve to reinforce the exclusion of products of developing countries from the markets of the industrialised countries. Consumers in the industrialised countries would not accept lower standards of food safety, while those high standards might represent a barrier to entry for producers in developing countries; and it is not obvious that it is possible readily to square this particular circle.

Codex policy-making institutions are as much in need of reform as the CGIAR research system, while in both cases highly politicised decisions are being taken beneath a spurious veneer of scientificity. Once again the case for more transparent and accountable policy-making processes is compelling.

CONCLUSIONS, QUESTIONS AND RECOMMENDATIONS: TOWARDS AN ACTION PLAN FOR REFORMING THE GLOBAL FOOD AND AGRICULTURE SYSTEM

1) CHANGING THE GOVERNANCE AND DIRECTION OF AGRICULTURAL INNOVATION

Given that an estimated one billion people are chronically hungry, the level of international attention given to food insecurity and the perversities of the global agri-food system has been disproportionately low. As a result of the recent food crisis and the publication and adoption of several recent strategy documents and major programme initiatives this is starting to change, but there is still a long way to go before we can ensure that hunger is given the attention and resources it deserves and requires (UK Cabinet Office 2008).

Developing countries are being confronted by multiple, diverse and uncoordinated food and agriculture policy and technology initiatives. Donors and aid agencies expect the governments of developing countries to supply innumerable different plans. Instead, nationally-developed and regionally-consistent hunger and right-to-food strategies should provide the bases for support from the donor organisations. The international community should support that rationalisation and work to ensure full participation of civil society groups in developing those national and regional right-to-food strategies.

2) GOVERNANCE AND TRADE

In relation to agriculture and trade, it will be critical for industrialised countries to dismantle the obstacles that they have established which adversely effect farmers in developing countries. One priority should be to rapidly accelerate the glacial pace at which the system of discriminatory tariffs is being dismantled. If the farmers of developing countries gained improved access to global markets it could encourage investment in their local agricultural R&D and innovation. The current subsidies regime is deeply damaging to poor farmers, and is unsustainable economically, politically and ecologically. Most support is provided to those who need it least and least support to those in greatest need. Many have responded by arguing that all agricultural subsidies should be abolished, providing a liberalised 'level playing field'. That approach is, however, deeply problematic. Firstly, liberalising agricultural markets under current conditions would entail that prevailing inequalities would be entrenched; small-scale farmers in Kenya could never compete with large-scale producers in Kansas, as US farmers have been tooled up with enormous amounts of science and technology, enhanced infrastructure and high-quality training and education that have been and remain inaccessible to most poor Africans. Secondly, subsidies serve not just to enrich farmers but also to stabilise prices that otherwise would exhibit considerable and unacceptable volatility. Countries that are free of chronic hunger are those that have agricultural policy regimes that stabilise commodity markets by, in effect, setting price floors below which prices will not fall and ceilings above which they will not rise.

Rather than abolishing all subsidies, what is required is a transformation of subsidy regimes to provide food market stabilisation in all countries, and by giving most support to those that need it most, and least to those that need it least. What are needed might well be termed 'smart and just' subsidies designed to eradicate rural poverty in developing countries, in ways that contribute to sustainable patterns of production and consumption in all countries, regions and communities. Malawi's recent success in providing targeting fertiliser subsidies to smallholder maize farmers offers a useful case in point.

BOX 1. SMART SUBSIDIES IN MALAWI

A landlocked country with a population of 13 million, a GDP *per capita* of $600, Malawi is a country that has experienced recurring famines throughout its history. Maize is the staple food crop, grown by virtually all 2.4 million farm families. Rainfall is erratic; often resulting in catastrophic drought spells during the rainy season at critical stages of maize growth. Even in years with good rainfall, the nitrogen-depleted soils cannot produce sufficient maize to feed the country, a condition common in much of sub-Saharan Africa.

Malawi suffered from very severe food shortages in 2001-03 and again in 2005. Those shortages were predictable, resulting from the combined effects of an impoverished and under-supported smallholder agricultural economy, a poor macro-economic situation, inappropriate policies and the ravages of the HIV/AIDS pandemic. Despite strong opposition from major donors, the government instituted a 'smart' input subsidy programme for the October 2005 planting season, by which farm households were given vouchers that entitled them to two 50-kg bags of fertilizer and 3–5 kg of improved maize seed, available at about 37% of the market price (Chinsinga 2007). The inputs provided through the scheme were sufficient for a 0.4ha farm but were not intended to distort the fertilizer market for larger purchases. The harvest in April 2006 greatly surpassed those in previous years. Maize production more than doubled nationwide, from 1.2 to 2.6 million tons, exceeding the national food requirement of 2.1 million tons and resulting in an 18% surplus.

Buoyed by this success, the government continued the subsidy policy for the next planting season. Again, rainfall distribution was good, and the 2007 harvest was a record 3.4 million tons, generating a 53% surplus above basic food needs. Malawi exported about 400,000 tons of maize to Zimbabwe from the 2007 harvest, generating foreign exchange, to the amazement of food-deficient neighbours. Malawi actually became a food aid donor to neighbouring Lesotho and Swaziland. President Mutharika concluded: 'Enough is enough. I am not going to go on my knees to beg for food. Let us grow the food ourselves. And indeed we have' (Mutharika 2008).

While favourable weather conditions played their part, the main cause of this production boost was the provision of quantity-limited subsidised fertiliser and seeds to smallholder farmers. The number of Malawians who faced significant food shortages decreased dramatically from 5 million in late 2005 to 500,000 in late 2007 (Dorward et al 2008).

Continuing the policies, this time with significant donor support, the 2008 harvest reached a 16% surplus. The lower surplus was partly due to less favourable rainfall distribution, but it was still enough to allow an increase of exports of maize in the region and sales to the World Food Program for its food relief programmes in Africa.

One of the major arguments against fertiliser subsidy is the fiscal burden on governments in very poor countries. However, the reality is that poor smallholders cannot afford to buy enough fertiliser to meet household needs at world market prices. Soil fertility had declined in Malawi and fertiliser was needed to replenish soil nutrients. Therefore, at least in the short term, a 'smart' input subsidy, limited in quantity and targeted at smallholder farmers, proved to be an appropriate way to address Malawi's food crisis.

The subsidy regime that dominated the European Common Agricultural Policy for much of its history was rightly criticised for generating huge, undesirable and expensive surpluses of, for example, dairy products, beef, wine and olive oil. It provided farmers with guaranteed prices for unlimited quantities of the selected commodities so giving them incentives to maximise their production, irrespective of levels of demand of amounts being consumed. Before 1973 when the UK joined what was then termed, the European Economic Community the British had a quite different subsidy regime. Farmers were guaranteed minimum prices, but only for the quantities of, for example, milk, meat, eggs and potatoes they could sell. That regime was known as the 'deficiency payments' system. Adopting arrangements of that sort would be far 'smarter' than crude subsidies on production (Tarrant 1980 p 100).

On the other hand, one of the key mechanisms available to public policy-makers to try to ensure food security and corresponding price stability is by creating strategic reserves of food stocks, bought when production is high and prices cheap, and sold when shortages threaten and prices might otherwise rise abruptly. In recent years, market liberalisers have persuaded governments of, for example, the USA and the EU Member States substantially to diminish their strategic food reserves and their market interventions. If those governments' stocks had been higher in 2008, and if they had been used strategically, the price volatility seen then would have been far lower, in part because far fewer profitable opportunities for speculative trading would have arisen (Mitchell 2008; Young 2008).

Public resources will need to be invested not only in measures to stabilise markets but also in education and training to enhance the productive capabilities and capacities of poor farmers and farming communities. Capacity development would be important in any event, but in context of climate change and environmental instability it is quite critical.

It will also be important for poor farming communities to be supported by services that can only be provided by non-commercial extension services. Those extension services should contribute by helping farmers to gain access to seeds, tools and other technologies, and to enhance their own innovative capabilities, as well as helping them with access to affordable credit and to markets for their products. Those extension services could also play a beneficial role by acting as intermediaries between farmers

and national and international research and technology development communities, to help align R&D agendas with the needs of poor farmers.

The recently-formed Global Partnership on Agriculture, Food Security and Nutrition potentially represents a positive step in rationalising the global policy-making architecture. Processes of reform must, however, be accomplished through effective and equitable negotiations amongst all groups of stakeholders. The interests of poor women, smallholder farmers and civil society groups, in particular, must be represented in these negotiations. In addition, the Global Partnership should be pursued through the renewal and restructuring of the UN Food and Agriculture Organisation; it should build on existing regional and global mechanisms and help in particular to develop more and better local and regional mechanisms.

The need for reforming the CGIAR system has been acknowledged in the *Integrated Reform Proposal - A Revitalized CGIAR: A New Way Forward*, which was adopted in Maputo in late 2008. It is now time to challenge the structures, practices and assumptions of dominant institutions (CGIAR 2008). It will be particularly important to reform their governance structures, and to take bold steps to reinvigorate and decentralise international agricultural research, and to transform the routes by which, and communities to which, it is held accountable.

The *Integrated Reform Proposal* adopted in 2008 argued for an increase in resources devoted to pro-poor agricultural R&D, as well as a reallocation of accountability for agenda-setting decision-making in agricultural R&D. That document also recommended that research teams and institutions should receive so-called 'performance contracts', as mechanisms to ensure such accountability. One way of introducing that approach could be to allocate funds to national governments as representatives of intended beneficiaries, rather than directly to the global CG institutions, and for those governments to award contracts for the development of pro-poor technologies and to monitor the performance of the contractors. Another would be to assign the responsibility for negotiating those contracts to new fora that would include representatives of for example small-holder farmers', women's and civil society organisations as well as southern governments.

The resources devoted to research in the CGIAR institutions are not intended primarily to enable scientists to try to satisfy their intellectual curiosity; on the contrary they are supposed to contribute in practice to improving the productivity and sustainability of agriculture for poor farmers and rural communities in poor countries. Consequently, there is a convincing case for separating institutionally the responsibility for deciding which lines of inquiry, research and development should be pursued, and for the allocation of resources across completing priorities, from responsibility for conducting R&D and delivering results. In the vocabulary of the British civil service, it is important to separate 'customers' from 'contractors'; those who conduct research should be accountable to others who have responsibility for setting priorities and allocating resources. But as Lord Rothschild and his colleagues emphasised as long ago as 1971, the customer-contractor relationship will only be effective if those setting priorities and allocating resources are 'intelligent customers' (UK Cabinet Office 1971). The phrase 'intelligent customer' was intended not just to suggest that customers needed to be bright enough to inter-relate the needs of and challenges to poor farmers with R&D agenda-setting, but also that they needed to be well-informed. To be well-informed, in the context of reforming the CGIAR system, means that those making strategic decisions, setting priorities and allocating resources need a rich understanding of the practical needs and circumstances of the intended beneficiaries, and of the conditions under which the outputs of the R&D system might improve sustainably the welfare of the intended beneficiaries. Consequently, in all relevant agricultural and food policy-making fora, the international community should ensure that representatives of, for example, women's, small-holder farmers' and civil society organisations as well as southern governments have an explicit role in contributing to agenda-setting and decision-making. With the active involvement of those groups, the UN and its member states could

accomplish radical reforms to the global food and agriculture system. Without them, it is quite likely that little will be accomplished.

While greater coherence and coordination will be needed to achieve the goals set out above, one single integrated global fund for agriculture would not provide an appropriate structure. Such a monolithic structure would be unable to address concerns about local and diverse forms of accountability, capacity and justice. Creating such a monolith would be a retrograde step because it would undermine opportunities for diverse groups exercising control over issues of directionality and distribution.

3) ADDRESSING DISTRIBUTION: INCLUDING A RIGHTS-BASED APPROACH

The economic growth strategies that have been pursued over the last quarter century, such as rapid deregulation of domestic agricultural markets, forced-but-partial trade liberalisation and an over-emphasis on production for export markets, have undermined domestic food production in many developing countries. They also substantially increased the power of agribusiness corporations, disempowered and impoverished hundreds of millions of smallholders, as well as farm labourers, and landless women, men and children.

Coupled with the neglect of agriculture by donors and southern governments,[2] those market liberalisation strategies have exacerbated rather than diminished rural hunger, poverty and inequalities. They have amplified some of the worst inequalities, and trapped hundreds of millions of small producers, farm labourers and plantation workers in chronic poverty. The conditions of millions of rural households that produce food are now characterised by extreme vulnerability and growing uncertainties.

Excessive dependence on food imports by poor countries has also exposed many poor people to increased price volatility and supply shocks. This has been reinforced by under-investment in domestic agriculture, with consequent balance of payments problems. It also compounded last year's global food crisis, which saw far larger price spikes in developing countries than in OECD countries, with consequent riots, hoarding and temporary export bans.

Instead of focusing on, or prioritising, growth in aggregates and averages, as some agricultural technology research teams still do, the development community and the governments of developing countries have to promote approaches that directly tackle poverty and hunger. This will mean promoting more accountable triangular relationships amongst donors, partner governments with citizens and representatives of civil society, while actively supporting participation by women's and public interest NGOs in policy-making deliberations.

One promising approach that could be adopted by bilateral and multi-lateral development agencies would be to work with partner governments *and* civil society groups to set up and enhance comprehensive, cross-ministry national right-to-food strategies. These should be guided by the FAO's 'Voluntary Guidelines' on the right-to-food adopted by the 127th Session of the FAO Council in November 2004 (FAO 2005). It would also be important to provide increased investment in pro-poor rural development, access to credit, land reform, universal social protection, enforcement of international labour standards and a focus on women's rights and vulnerable groups.

[2] Donor support for agriculture has slipped from 18% of total ODA in 1979 to 3.5% in 2004, according to the *World Development Report 2008* http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTRESEARCH/EXTWDRS/EXTWDR2008/0,,contentMDK:21410054~menuPK:3149676~pagePK:64167689~piPK:64167673~theSitePK:2795143,00.html (accessed 11 June 2009)

Economic policies will need to support such a right-to-food approach. One critically important set of economic policies in this context relate to trade. The international donor community should commit to building resilience and fostering growth in local, domestic and regional agricultural markets as a priority (over global markets) with a particular focus on enhancing the role of women, small holders, and vulnerable and marginalised groups. Accordingly they should adopt global, regional and bilateral trade rules that allow southern governments sufficient 'policy space' to protect and promote local and domestic agricultural systems. At the same time, all donor governments should make deep cuts in their own national subsidies that entail flooding local markets in developing countries with cheap and often dumped agricultural products (FAO undated).

The huge build-up of speculative investments into food commodities futures and options contributed conspicuously to the 2007/8 food price crisis, which highlights the need for new measures to stabilise agricultural markets, including curbs on destabilising speculation in agricultural commodities and futures (Mitchell 2008; Young 2008). The G8/G20 Member States should curb such speculation and develop new systems of national and regional grain reserves to shield countries and regions during periods of short supply.

The international donor community should recognise these challenges and show leadership by tackling the remarkably high levels of corporate concentration in global agribusiness, commodities and retail markets. The world's top 10 seed corporations have a combined proprietary share of 67% of the global seed market and 89% of the agro-chemical market, and consolidation continues apace (ETC 2008). The G8/G20 Member States should establish regulatory regimes to prevent and dismantle monopolistic and/or oligopolistic control over the agricultural supply, the food trade, and processing, catering and retail sectors. Land reform in developing countries is a critical issue that remains to be adequately addressed.

4) PROMOTING DIVERSIFICATION: OPENING UP MULTIPLE PATHWAYS TO A SUSTAINABLE AND SOCIALLY JUST FOOD SYSTEM

Agriculture is now recognised as both contributing to and suffering from the negative effects of climate change. Agriculture accounts for as much as 32% of global anthropogenic greenhouse gas emissions, if deforestation is included (Evans 2009). At the same time, climate-driven water scarcity and increases in the severity of droughts and floods will affect food production, especially in subsistence sectors.[3] Smallholders, pastoralists and fisher folk will suffer complex and localised effects of climate change. According to a recent study by the IPPC, yields from current forms of rain-fed farming in some African countries could fall by up to 50% by 2020, and by up to 30% in some central and South Asian countries by 2050 (IPCC 2008).

While the UN FAO argues that global agricultural production must rise 50% by 2050 to keep up with population growth and changes in diets, the UNEP has estimated that the combined effects of climate change, land degradation, cropland loss (such as to biofuels, timber and urbanisation) (Evans 2009), plus water scarcity and species infestation may cause projected yields to be 5-25% short of estimated levels of aggregate demand by 2050 (UNEP 2009). Responses to the hunger crisis have focused on increasing aggregate production through the adoption of high-input, carbon-intensive technologies. That approach assumes that increased access to improved seeds, inorganic fertilisers and agrochemicals (all requiring more energy) will lead to greater crop yields, which in turn will decrease hunger.

[3] An estimated four billion people will live in countries chronically short of water by 2050, not only because of climate change, but also because of unsustainable extraction, according to IPPC. Agriculture, which accounts for 70% of global fresh-water use, will be particularly vulnerable

While higher yields from land and labour are often important, a narrow focus on their attainment through for example applying inorganic fertilisers and improved seeds overlooks the underlying causes of hunger and low yields. Improving yields only helps the poor if the benefits accrue to that group. Increasing aggregates without diminishing maldistribution does not contribute to poverty reduction. It might result in lower prices at just those points in the harvest cycle when poor farmers need to sell some of their crops. It is also important to appreciate the multiple functions that agriculture does and can play. Agriculture can variously contribute to securing food for poor people or to undermining it, increasing or reducing greenhouse gas emissions, maintaining or undermining ecosystems services and providing or destroying the ways of life for billions of people.

The global agricultural research and development community, currently led by the CGIAR, should be radically re-organised. Instead of focussing solely on top-down researcher-led initiatives, the system should be de-centralised and made far more responsive to the needs of the rural poor. The success of the System of Rice Intensification (SRI) demonstrates how a decentralised innovation network has grown by adapting to diverse local realities (see Box 2).

BOX 2. THE SYSTEM OF RICE INTENSIFICATION AND THE EMERGENCE OF AN INNOVATION NETWORK

There has been a growing dissatisfaction amongst innovation analysts with the closed and unidirectional assumptions of the traditional model of agricultural innovation. The traditional orthodox model of innovation has been linear and unidirectional, assuming that the source of innovation is cutting edge scientific research, which develops novel products and processes, which are then disseminated to extension services and via commercial networks to farmers to adopt what is presumed to be superior technology. The uptake of innovations that had been developed in isolation from end-users was not as extensive or as sustained as researchers had anticipated or as 'pro-poor' as they often claimed. Many of the innovations benefited relatively advantaged farmers rather than those less well-endowed or more marginally located, and low rates of adoption could not be attributed to limitations in extension services.

Several more recent alternative models have had various designations such as 'participatory technology development' and 'farmer participatory research and extension', each involving equilateral and interactive relationships amongst researchers, extensionists and farmers. While there has been growing support for such reorientations, there is not yet a consensus on what should replace the standard linear model of agricultural innovation. Unidirectional linear models assign to extensionists the role and responsibility for communicating innovations to farmers and portrays farmer as having the limited and tertiary role of 'adopters'.

The case of the System of Rice Intensification (SRI) offers a valuable case in point. SRI did not originate within the precincts of institutionalised scientific research. Rather, it stemmed from the endeavours of French agronomist priest Fr. Henri de Laulanié working closely with small farmers and *Association Tefy Saina*, a local NGO in Madagascar, and guided more by observation and practice to increase rice production than by theory or accepted scientific knowledge. Over the past decade, SRI has spread widely, especially in Asia and Africa, and achieved some spectacular results in some places, particularly in marginal areas. Despite the availability of impressive evidence, the SRI has been regarded by some in the scientific rice establishment as illegitimate and unproven, and consequently SRI has often been rejected; established scientists have often dismissed any suggestion that SRI might have something to offer. Initial assessments of SRI published in the scientific literature dismissed the innovation as unimportant, and even disparaged it (McDonald et al 2006; Doberman 2004). This often out-of-hand rejection has demonstrated an unwillingness to reflect and learn, and a surprising lack of openness to new ideas and to impressive experimental data, something normally associated with good science.

SRI has spread, by force of circumstance, through the efforts of a great variety of individuals with NGO, university, farmer organisation, private sector or other affiliations who share an interest in low-external input, sustainable or alternative agriculture who together created informal 'learning alliances' and 'innovation networks' (Prasad 2009).

Some mainstream scientists have responded positively to the potential of SRI, particularly those working in the national agricultural research systems of China, India and Indonesia (Yuan 2002; Sato and Uphoff 2007; Sinha and Talati 2007). Scientists taking a sympathetic interest in SRI were often ones who were already working closely with farmers and NGOs, and who did not regard work on research stations or in laboratories as sufficient or conclusive. They were willing to visit SRI fields and talk with SRI farmers and to rely less on *a priori* reasoning or second-hand claims. They also did not believe it necessary to defend their traditional scientific practices against the 'intrusions' of non-scientists who were suggesting reasons for a paradigm shift in rice production. (Mishyra et al 2006)

As Norman Uphoff, one of the leading promoters of SRI, has observed: 'The spread of SRI through word of mouth, photocopies, unpublished reports and e-mail contacts has been dramatic and fast. Capacities for electronic networking have meant that the 'gate-keeping' role previously played by recognized experts in any field, not just in rice science, has been changed and greatly reduced. This can have some negative consequences, as unvetted and misleading information can now be transmitted freely at the speed of light. On the other hand, valid and productive information can be spread just as fast, and if it proves beneficial, it will gain a growing number of users and supporters' (Uphoff 2009).

Today SRI is gaining increasing acceptance and momentum as over one million farmers in more than 25 countries are using its methods to increase their rice production while also reducing their use of external inputs. The core of SRI is based on a set of general principles that need to be translated into specific practices, and adapted to local conditions. SRI claims to create more favourable growing environments for irrigated rice cultivation by changing the management of plants, soil, water and nutrients. Proponents argue that SRI practices lead to healthier, more productive soil and plants by supporting improved root growth and by nurturing the abundance and diversity of soil organisms. The agro-ecological principles that contribute to SRI effectiveness have good scientific bases. SRI concepts and methods have been successfully adapted to upland non-irrigated rice, and they are now being extended to other crops such as millet, wheat and sugar cane.

Reformed agricultural research institutions should focus on 'low carbon' smallholder-based ecological farming systems to increase food security and help the farmers to cope with climate change. This will mean supporting small-scale farmers in developing diversified and resilient eco-agriculture systems that provide multiple ecosystem services – water supply and regulation, habitats for wild plants and animals, genetic diversity of flora and fauna, pollination, pest controls, climate regulation – as well as adequate food to meet local and consumer needs. Priorities for agricultural research should increasingly be set by institutions and processes that actively include the perspectives and representatives of poor farmers. A commitment to shift, for example, 30% of all CGIAR's R&D expenditures by 2015 to farmer-led projects, and to national agricultural research institutions rather than global ones, could make a substantial difference.

There is already one helpful road map indicating how those goals might be achieved - the International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD) – which has been endorsed by many governments around the world. IAASTD sets out the case for lower-input and biologically diverse ecological agriculture, and indicated how it could be promoted. The report also highlighted the failure of previous agricultural revolutions to reach the poorest people as well as the adverse socio-economic and ecological impacts of intensive farming systems.

The New Sussex Manifesto endorses the central tenets of the IAASTD, when it calls for much greater involvement of women, local innovation and control of agricultural development and for better use of existing agricultural knowledge, science and technology – formal, traditional and community-based. Women in particular, who in poor communities take primary responsibility for arable farming, could substantially contribute shaping agricultural R&D agendas and rural extension services.

The international community should recognise the emerging consensus that agrobiofuels do not currently provide a solution to climate change. In fact aggregating over their lifecycle they are often

counterproductive, releasing more carbon dioxide than fossil fuels (Tilman et al 2006). Moreover, biofuels contributed to food-price volatility, especially in 2008, and the impact on food prices was particularly severe in many developing nations.[4] Donor governments should call for the withdrawal of targets, subsidies and other financial incentives to cultivate agrobiofuels in the North and should focus instead on supporting developing countries to develop sustainable bioenergy strategies.

The current structure and operations of the international agricultural and food system are economically, ecologically and ethically unsustainable. Problems of maldistribution remain acute, while diversity that could contribute to sustainability has been diminished. Patterns of technological change and agricultural innovation have been pivotal to those developments. Public policy regimes and agricultural R&D programmes have contributed to making cheap food most readily available to those who already have enough to eat, but least food to those who need it most. Similarly, with agricultural innovations, most help has been available to those who have needed it least and least to those who have needed it most.

Consequently the international and national food and agricultural systems need to be restructured in a way that redistributes resources and support in favour of the poorest and the most hungry. It needs to provide greater stability of supplies and prices to all groups, countries and regions, and facilitate the development of innovative ways of producing, storing, processing and distributing foods that are healthier, safer, more equitable and more sustainable. Poor farmers and farm labourers in developing countries need to be able to enhance, and benefit from, their own innovative capabilities, so that they can choose amongst multiple and diverse pathways to provide their communities with food security, which can be socially, economically and ecologically sustainable.

[4] The sudden and dramatic growth in demand for agrofuels may have been an important factor behind the food price crisis, increasing food prices by between 30-75%. For example the research institute IFPRI attributes 30% of the increase to agrofuels while the World Bank says 75% of price increases are a result of agrofuels

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