Hans R. Herren, Benedikt Haerlin, IAASTD+10 Advisory Group

Transformation of our food systems

The making of a paradigm shift

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Editors

This book was edited by Hans R. Herren, Benedikt Haerlin and the IAASTD+10 Advisory Group.

The IAASTD+10 Advisory Group

The book's Advisory Group consists mainly of former authors and review-editors of the International Assessment of Agricultural Knowledge, Science and Technology for Development. It was convened by Hans R. Herren and Benny Haerlin at the occasion of the 10th anniversary of the publication of the IAASTD in 2019. Initially aiming at a conference taking stock of the developments in the area of global agricultural practices and policies since 2009, the group decided that this publication would serve this purpose better and in a more sustainable way. Its members have discussed key questions to be raised and answered in this book and the list of international reports and initiatives to take into account. They also reviewed individual articles.

Members of the IAASTD+10 Advisory Group

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Zukunftsstiftung Landwirtschaft (Foundation on Future Farming) is a German charity promoting organic and agro-ecological innovation and research with a focus on breeding new varieties for organic agriculture. Its campaign office in Berlin addresses issues of genetic engineering and national, European and global food and agricultural policies and runs an educational field with 45 different crops. Since ten years, it presents the IAASTD and its follow-up on its websites Weltagrarbericht.de and globalagriculture.org. www.zukunftsstiftung-landwirtschaft.de

Biovision Since 1998, Biovision has been promoting the development, dissemination and application of sustainable ecological agricultural practices, allowing people in the developing world to help themselves. In 2013, Biovision and its founder Hans Rudolf Herren won the Right Livelihood Award, also known as the Alternative Nobel Prize. Biovision Foundation is a charitable organisation in Switzerland. www.biovision.ch

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Layout & Book Design
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Printed by
Triple AAA Druckproduktion, Gilching, Germany

ISBN 978-3-00-066209-6
www.globalagriculture.org

Content

Infographics

“It is no longer enough to do our best, we have to do the seemingly impossible”

Greta Thunberg

Hans R. Herren

Introduction

"It always seems impossible until it's done"
Nelson Mandela

In 2008 in a bleak conference room in Johannesburg, South Africa, a report of enormous scientific and political undertaking was finalized. The report, entitled The International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD) had the phrase 'Agriculture at a Crossroads' as its tagline and key focus. This book takes you, the reader, on a journey through the intervening ten years, offering thought provoking articles on the agriculture, nutrition and food production systems related to, and inspired by, this groundbreaking report.

A series of thirteen short essays, in chronological order, will delve into selected landmark reports that were inspired by the IAASTD and originated in the same concern for the urgent need to change how our food is produced. It highlights how a new food system narrative has been firmly established since 2008, which is distinctly different from the post-war chemical narrative that still dominates mainstream farming. In addition, the book contains a series of articles and updates on key topics of interest, written by authors from the original IAASTD report. These articles range from trade, corporate concentration and proprietary strategies to urbanization, innovation, and indigenous community-based research.

This book highlights how a new food system narrative has been firmly established since 2008 which is distinctly different from the post-war chemical narrative.

The authors involvement took place in a rather passive, volunteering way, working with respondents to a broad call to the IAASTD authors and reviewers for action on a book to document the steps undertaken over the past 11 years. This led to a geographical and cultural imbalance and we do not claim to cover the full spectrum of views on the new paradigm for the agri-food system, even though we can safely assume that the progressive forces are closely lined-up to the basic principles of agroecology in its widest sense.[1] The Advisory Group, a subset of the book's authors, does not have worldwide representation and recognizes that it does not contain many highly relevant advances in sustainable agriculture from areas outside their personal experience.

This book was written during the coronavirus pandemic, which served to remind us, in a terribly brutal way, of the direct link between industrial agriculture

and human health. This pandemic has brought into plain sight the shortcomings of the present food system, and the need to heed the warnings and options for action enshrined in the IAASTD report and many more to come. The 2015 report published jointly by WHO, UNEP and CBD was crystal clear about this link, stating that "Changes in land use and food production practices are among leading drivers of disease emergence in humans."[2]

IAASTD

The International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD) was initiated at the 2002 Rio+10 Summit on Sustainable Development in Johannesburg, South Africa, when the World Bank and the Food and Agriculture Organization of the United Nations (FAO) suggested that an international assessment of global agriculture should be carried out. In 2004, six UN Agencies, the World Bank and 60 nation states agreed to carry out the IAASTD, which would consist of: a global report, five sub-regional reports, and executive summaries for decision makers.

As the final plenary in Johannesburg was being held, with the adoption of the Synthesis Report and Executive Summary in April 2008, the world was not only dealing with a major food crisis, but also slipping into a new financial and economic crisis, which would have broad implications for food security. Today, twelve years on, as we are finalizing a book to document what has been achieved since the publication of IAASTD, we are deep into the COVID-19 pandemic, which will have even greater economic and social impact than the financial crisis of 2008. It is increasingly clear that this aggressive zoonotic virus highlights the general unpreparedness of our health services; our immuno-deficiencies triggered by a food system that leaves hundreds of millions of people obese, hungry and malnourished and exposes the public to cocktails of chemical residues in the water, air and food. A perfect storm has thus caught our leaders off-guard and scrambling for solutions. Resting on the laurels of food surpluses and a relatively strong economy is no longer an option. The key words, now and for the future, are as we are regularly reminded by our governments, 'foresight, preparedness and resilience'. This of course was the fundamental message detailed in the IAASTD's "summary for decision makers", now all the more urgent for leaders of global food systems to act upon. However, politics, vested interests and false promises still stand in the way.

Today, deep into the COVID-19 pandemic, the early warning of the IAASTD report that "business as usual is not an option" should finally resonate with world leaders.

Now that hundreds of millions of people, both in industrial and low and middle income countries are thrown back into poverty, hunger and homelessness, the early warning of the IAASTD report that "business as usual is not an option" should finally resonate with those leaders who should already have taken the lead in promoting the agriculture and food system transformation. As the COVID-19 pandemic was spreading, both the UN Secretary General[3] and WFP Chief [4] war-

ned that immediate and substantial aid was needed to avert a hunger crisis. The fragility of the present globalized, industrialized food system that we are now witnessing in the Covid-19 pandemic, was amongst the key warnings of the IAASTD report, that was itself following on the heels of the SARS outbreak of 2002/2003.

The 400 IAASTD-authors from around the world – from farmers to academics and decision makers – sent a clear message, that there is a need to transform agriculture from its unsustainable industrial/conventional model relying on external inputs and large scale farms to an agroecological model, which is fully able to nourish a world population of 10 billion people by mid-century. There is ample peer reviewed scientific evidence for this as detailed in this book.
In setting up the outline of the IAASTD, we paid attention to the three dimensions of sustainable development and addressed them to the fullest extent possible. The main objective was a thorough analysis of the lessons to be learned from the past 50 years and an outlook on the challenges of the next 50 years, even as that long view would remain challenging to predict. The central question asked of the IAASTD was 'could key principles be identified for a food system that takes into account not only production aspects, measured in yield per hectare, but also socio-cultural and environmental conditions of providing healthy nutrition for all'? Looking back 50 years proved to be relatively easy, with the green revolution and a globalized food system that concentrated on the calories produced without including the nutrition and safety aspects. Envisioning the future and coming up with real solutions that tackle the cause of the problems rather than the symptoms proved, unsurprisingly, to be more complex.

The late introduction of the "K" for knowledge, which never made it into the acronym of the IAASTD, became a harbinger of one of the report's missed opportunities. The push for inclusiveness across the world's diverse agriculture and food systems remained incomplete. The authors' list was extracted from the nominations of governments and civil society by a bureau consisting of 30 government and 30 civil society, academia and private sector representatives. There were fair complaints that some groups central to the report's topics were seriously underrepresented such as indigenous people, livestock and fisheries experts, and the wider farming community. This was not least a result of English being the only working language, due to cost considerations.

It is noteworthy to recall that we did not write a review of agriculture, we were asked to write an assessment, which is a "critical evaluation of information, for purposes of guiding decisions on a complex, public issue". The topic of the assessment was defined by the stakeholders, in several regional meetings, who were typically decision-makers; it was to be policy relevant, not prescriptive; to be conducted by a credible group of experts with a broad range of disciplinary and geographical experience, in a balanced and transparent way; it should reduce complexity but add value by summarisation, synthesis and sorting what is known and widely accepted from what is not known (or not agreed); it should

relate to the situation at a particular time and in a given geographical domain and often repeated after a period of time.

Frustratingly., with the launch of the assessment reports in the midst of a financial crisis, little attention was paid to agriculture and food by the media. The main economic players and governments were busy implementing yet a new set of quick fixes to avert the worst impacts of the financial disaster they were facing, and were not ready for a report on the resilience and future of agriculture and the food system. This was not the case amongst Non-Governmental Organizations, where the IAASTD found fertile ground and was met with interest and an eagerness for its actions to be implemented. Unfortunately, the World Bank, the original initiator of the assessment, was an early critic of the report when it was still in its draft form, as were some industry representatives.

Post-IAASTD

After a decade of working with the IAASTD results, this book takes stock of its impact by looking at what has been taken up directly, what follow-up reports and actions have been catalyzed and how policies from global to local have been influenced. There has been genuine pick-up of the IAASTD's "options for actions" by production groups, research organizations, NGOs and some foundations. There has also been a fair amount of co-opting our central message that 'business as usual was not an option' and 'the need of a paradigm change' for green washing purposes. However, an example of how little has changed where such change is most needed, is the fact that most public and private R&D investments are still going to conventional green revolution and industrial agriculture technologies and practices.[5] At the center of these money flows lies the fact that, through the ages control of food has always been, and continues to be, one of the most important tools used to enforce power over people.

After a decade of working with the IAASTD results, this book takes stock of its impact by looking at what actions have been catalyzed and how policies from global to local have been influenced.

This book presents the steps that will set the stage for the inevitable transformation. In the same way that steam engines paved the way for internal combustion engines, which are now about to yield to electric engines, in agriculture, outdated chemical and energy intensive technologies will either yield to modern agroecology, or simply go out of business.

The book's Advisory Board has reviewed and selected landmark reports, published since 2009, and inspired by the IAASTD. The reports address the same concerns as the IAASTD, filling some of its gaps and further elaborating its initial message. The corresponding thirteen essays in this book are presented in chronological order. This provides an interesting account of the further evolution in thinking and adoption of the IAASTD's main findings with a remarkable acceleration over the last three years.

In addition, authors from the original IAASTD report have contributed a series of thought pieces and updates on topics of interest and elaborated on areas that did not get the deserved attention in the 2009 IAASTD report. Many authors have reiterated the key place and value to society of the socio-cultural and spiritual aspects of agroecology, as practiced by indigenous and local communities. The disconnect between humanity and nature, a hallmark of industrial agriculture, requires diverse solutions in order to repair and heal the impact of previous policy.

As we work to transform the food system, the goal is to go beyond the overflowing plate and profit maximization, which is still the central driver of many in agribusiness. The voices we are increasingly hearing from many sides of the debate is for policy to be rolled out that allows for a society to live in harmony with its environment. The concept of "Buen Vivir" and the corresponding transition to a sustainable economy, rather than development', confirms the need for a new economic system, which can handle all dimensions of sustainable development. Much has been learned in the past decade about nutrition and the way food is produced, transformed, marketed and consumed. Several contributions highlight the agriculture and health nexus, and the cost of ignoring how, where and by whom food is being produced, processed, transported and distributed along the value chain. How we produce both crops and animals has major implications regarding climate change. The reader will thus be provided with the key data relevant to carbon sequestration and the much-disputed impact of grazing modes.

The title of the 2019 FAO-HLPE report "Agroecology and other innovations" carries a major contradiction, given that agroecology is not just a technology but a holistic system, integrating science, knowledge and skills as well as technologies and innovations. This should of course all be in the service of the farmers (not the input industry) and preferably sourced from the pool of public goods. Two contributions cover controversial technological developments: digitization and biotechnology. While digitization had not yet played a major role in the IAASTD, biotechnology, GMO's in particular, had been a major bone of contention in the final plenary and drove some countries and industries to distance themselves from the report. In digitization, ownership of information is as controversial as in the seed sector. For GMOs, ten years on, we are still waiting for compelling proof that they make any significant contribution to resolving problems that could not be achieved more effectively, and with more resilience, regeneration potential, and at lower costs than with other technologies. Almost superfluous to mention that GMOs, by their nature, deal with the symptoms rather than the causes of the problems they are intended to solve. Good for business, bad for farmers.

In **2011**, a landmark report from the EU's Standing Committee on Agricultural Research (SCAR) defined scarcity as the new mantra in times of humanity exceeding the planetary boundaries of natural resources as detailed by Rockstrøm et al. The report spelled out two competing narratives of "productivism" and

"sufficiency" and warned that the complexity of interconnected drivers and their non-linear feedback loops prevented reliable scientific predictions. This required robust and precautionary reactions prioritizing sufficiency-oriented research, innovation and communication in an ever-accelerating combination of crises.

UNCTAD took a different line with its report "Wake up before it's too late" in **2013**, which strongly promoted organic and agro-ecological farming practices in relation to trade. UNCTAD had already called for more resilience in the face of climate change by shifting the green revolution paradigm to ecological intensification and the use of regenerative production practices with an emphasis on the small-scale farmers.

The **2015** Sustainable Development Goals (SDGs) or Agenda 2030 of the United Nations were probably the most comprehensive and significant global agreement on the future pathway to sustainability. Civil Society Organizations dealing with agriculture and related disciplines from health to environment gathered and in a common effort produced a manifesto: "Time to Act", which greatly influenced the development of SDGs targets and their approval by all governments. The manifesto was based on the key findings and options for action from the IAASTD report. The consultation process leading to the SDGs was a catalyst for a flurry of additional reports. As a result, the framing of the SDGs marked a key global step towards the new systemic approach to food, health, agriculture, climate, soil, water and biodiversity, within the realm of the three sustainable development dimensions.

Amongst all the UN agencies, The United Nations Environment Programme (UNEP) took the greatest interest in the IAASTD during the drafting phase and at the final plenary in Johannesburg, where the UNEP's then Director General, Dr Achim Steiner made a passionate speech about the linkages between agriculture and the environment. A chapter dedicated to agriculture in UNEP's Green Economy Report (2011), based strongly on the IAASTD spirit, modeled the costs for a global transformation of agriculture at US$142 billion until 2050, equivalent to one third of the present annual subsidies to agriculture.

UNEP's **2016** report "Linking Food Systems and Natural Resources" strongly contradicted a food systems model assuming that there is no limitation to the substitution of nature with chemicals to grow the food needed by an increasing and ever more demanding population.

The UNEP's **2018** TEEB-Ag report assumes, as a leverage point for the transformation of food systems, that consumers' education about the environmental, social and economic consequences of their choices at the supermarket or market, and their wallets, can have an important impact as a driver for change. Calculating the price of food as a cascade of savings due to reducing pollution, addressing climate change impacts and biodiversity loss, along with related health

care and research costs shows that these savings would make up more than the price of supporting the poorer segment of the population.

In 2011, The Food and Agriculture Organization of the United Nations (FAO) presented its own concept of the transformation that was needed, with the publication of their "Save and Grow" report, to present "sustainable intensification" as the "new paradigm", again taking cues from the IAASTD report. This report can be seen as a first example of co-opting agroecology while pursuing a business as usual agenda. However, the IAASTD still worked its way slowly into the FAO policy development process. The culmination of the changes brought to the thinking at FAO by the then Director General, Jose Graziano, is best illustrated by the series of conferences convened by FAO from 2016 to 2018 on agroecology. In 2014, he stated that the cathedral of the Green Revolution had opened at least a window to agroecology. This led to the Committee on World Food Security (CFS) commissioning a report from its High Level Panel of Experts (HLPE) on "Agroecology and other innovations", first presented in **2019**, which outlines a transformation of agriculture and food systems and lists policies leading to the expected changes.

The **2019** IPCC special report on Climate Change and Land has given a major boost to the food system change debate. Although it does not reference the IAASTD report, its authors have clearly drawn from it with messages that point in the same direction of transformational changes, with an emphasis on the role of biodiversity in the food chain, agroecological practices, inclusion of local knowledge and empowerment of women and youth. It is a rewarding read for those who have been waiting for this report over the past decade.

In this book, the authors are illustrating the "behind the scene" stories about landmark reports that have emanated from the IAASTD.

The Beacons of Hope Report, published in **2019** by the Global Alliance for the Future of Food and the Biovision Foundation, has searched around the globe for practical examples that could accelerate the transformation process. The main criteria were impacts of these new food systems on the environment, livelihoods and health. The report also outlines key elements of successful transformation pathways, and how to grow them to scale.

In this book, the authors of the essays and short stories are illustrating, in a narrative form and their own words, the "behind the scene" stories about these and other landmark reports that have emanated from the IAASTD. It is hoped that with this book we attract the further attention of decision makers to the challenges, the solutions, and the actions necessary to address them. Food is a human right, and it is the responsibility of governments to ensure that all have access to the right quantity and quality of healthy food at an affordable price, which has been produced for the long-term from resilient systems, many of

which must be rebuilt on the ruins of degraded soils, lost biodiversity and impoverished farmers. It's high time that our food systems pay attention to the word regenerative, as sustainable and resilient systems can only function as such in fully restored ecosystems. Time is ripe to move from exploitation to management of our life supporting ecosystems.

With a major gathering planned under the auspices of the UN Secretary General, Food System Summit in 2021, managed by private foundations and private sector representatives, this book could not be timelier, bringing a strong warning that "business as usual is not an option", and that if this is not heeded, it's not people but the irrevocable damage to nature that will destroy our civilization. One could ask where were the initiators and leaders of the 2021 Food System Summit over the past 11 years? It is clear that food systems and the value of a "systems approach" has been suddenly (re)invented and re-interpreted. We must defend the narrative we have developed in 2009 and refined since, which is now very much in jeopardy again and keenly aware of the impacts of the co-optation of language while continuing on the same path. History has a tendency of repeating itself.

This book is a treasure trove for decision makers with any kind of responsibility across the food chain. It is also relevant to the general public as it explains clearly what the consequences of their choices are. Our hope is that decision makers, NGO officials and the wider public read this book and do their absolute best to implement its lessons – our current and all future generations will be eternally grateful if they do.

It is our common future, and our common duty to act fundamentally differently.

Endnotes

1 Steve Gliessman (2018). "Defining Agroecology". Agroecology and Sustainable Food Systems, 42:6, 599-600. See also Clara Nicholls and Miguel Altieri (2016). "Agroecology: Principles for the Conversion and Redesign of Farming Systems". Journal of Ecosystem and Ecography

2 https://www.cbd.int/health/SOK-biodiversity-en.pdf

3 https://www.weforum.org/agenda/2020/04/covid-19-coronavirus-could-double-acute-hunger-un-warns/

4 https://insight.wfp.org/wfp-chief-warns-of-hunger-pandemic-as-global-food-crises-report-launched-3ee3edb38e47

5 http://www.ipes-food.org/_img/upload/files/Money%20Flows_Full%20report.pdf

Hans R. Herren, founder and President of the Biovision Foundation, is President of the Millennium Institute. He was Director General of the International Centre of Insect Physiology and Ecology, Kenya and Director Plant Health Division at the International Institute of Tropical Agriculture, Nigeria. He has been awarded among others the Right Livelihood Award 2013; World Food Prize 1995, Tyler Prize for Environmental Achievement 2003, the NAS and the Third World Academy of Sciences membership and is member of IPES-Food and the IFOAM-OI World Board

Preface

Benedikt Haerlin

The making of a paradigm shift

"Business as usual is not an option" has become a widely-used maxim since appearing in the press release on the final report of the International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD) in April 2008. One decade later, the majority of the academics, policy makers and institutions involved seem to agree on the fundamental need for a transformation of food systems at both local and global levels. In addition, the spirit of change has accelerated over this period, emerging from a groundswell of innovative grassroots initiatives, old and new, from field to fork.

More than a decade ago, the IAASTD identified a number of major shifts and policy options that would contribute to the reduction of hunger and poverty, the improvement of rural livelihoods and human health, and facilitating equitable, socially, environmentally and economically sustainable development. These included:

- Favourable and just conditions for small farmers, especially women, in terms of their access to land, resources, seed, knowledge and markets;
- Support for and investment in agroecological practices, innovation and research;
- Complementing the concept of food security with that of food sovereignty as the right of peoples and sovereign states to democratically determine their own agricultural and food policies;
- Fair and equitable terms of trade, designed to overcome the 'global treadmill' and foster local and regional value chains, offering greater protection from financial speculation, international corporate domination and corruption;
- The revalorization of indigenous, traditional and local knowledge and a participatory approach to knowledge production and sharing that is solution oriented instead of technology driven.

The complexity of food system and ecosystem approaches is being addressed today by an emerging discipline, or rather trans-discipline, of agricultural, ecological, economic and health knowledge. Pathways to holistic and multifactorial approaches have been increasingly conceptualized and elaborated. As a result, a new food system narrative has been firmly established over the past decade. This new narrative is distinctly different from the post-war industrial and chemical narrative whose fame and glory culminated in the Green Revolution and which still dominates mainstream farming. It also goes well beyond concepts of sustainable intensification merely trying to improve the resource efficiency of productivism.

Narratives and fashions come and go. However, what has developed over the past decade is more than this. A real paradigm shift for agriculture, nutrition and food systems has emerged. Such a paradigm shift entails the change of prevailing questions and priorities to be answered within a conceptual framework accepted by a majority of the scientific and expert community and those following their knowledge system. Thomas S. Kuhn defined paradigms in 1962 as "universally recognized scientific achievements that for a time provide model problems and solutions to a community of practitioners" . Paradigms are questions, methods, patterns and models, not answers. They provide room for lively discussion and competing concepts as well as different approaches, including a pluriversity of knowledge systems well beyond classical western natural sciences. However, they do exclude answers to questions not asked. A good example of such a paradigm shift is the role that Climate Change considerations have in global priority setting.

Amongst the key elements of the new paradigm for food and farming systems is the recognition of planetary boundaries and natural scarcities, including rapid climate change and biodiversity loss as well as the scarcity of time left for addressing these issues. The drama of the predictions of the IPCC (see page 150) as well as the IP-BES (see page 104) becoming true and visible in even less time than expected is defining the global modus operandi under which we have to address the questions of the new paradigm.

Integrating previously segregated sectors of production, processing, trade, consumption, environmental assessment and health, as well as knowledge systems into the concept of food systems substantially extends the scope and complexity of the approaches that are needed. Together with the recognition of social inclusion and human rights as critical systemic factors in any sustainability equation this systems approach has gained weight enormously over the past decade. The new paradigm of agri-food systems also integrates the implementation and cost of public and personal health as part of the economy of food and agricultural production. Lifestyle, mass communication and its manipulation, and sociodemographic developments have all been acknowledged as drivers of our food systems. As to whether the archaic and modern myth of "more food is needed – production must increase!" has already been overcome by a differentiated "only produce or take what is needed" as a part of the emerging paradigm shift is still too close to call.

The level of complexity that emerges from this new paradigm is higher and more challenging than its green revolution predecessor. This leads some scholars to believe that only computed modelling, big data and artificial intelligence will be able to solve the riddle. De-humanisation by means of digitization has become a conceptual approach to managing this complexity. Resorting to tools and technologies instead of values to answer what are basically political and social questions is not new. However, this ideological mistake is at the root of

many of the disasters that must now be urgently managed and healed. Re-humanising, reconnecting, rebuilding and restoring the resilience of our food systems is a distinctively different response to the same set of undeniable challenges.

The past decade saw the formation of agroecology as a uniting conceptual framework for addressing the new paradigmatic questions. At the same time, evidence has emerged of the importance of myriads of diverse local forms of implementation; traditional and new. Agroecology both as a social and cultural concept and as a set of agricultural and food system practices is certainly one of the most holistic and convincing approaches to the challenges of the new paradigm. While diversity is the mantra of agroecology at every level from local practices to global understanding, the beauty of the approach is that it provides plain and simple answers. These are based on human values and compassion to many uncomputably complex questions. The IAASTD has contributed substantially to the adoption of agroecology over the past decade.

The emerging food and agriculture paradigm shift contrasts with the insufficient and sometimes counterproductive political and economic approaches of governments and global corporations and their national and international value chains. This is not an entirely new illustration of practise not following knowledge. Threats to the resilience of ecosystems and sustainable use of natural resources and critical material cycles have increased over the past decade. All planetary boundaries, except the ozone layer, are being stressed harder today than ten years ago. Loss of biodiversity, mounting greenhouse gas emissions, degradation of soil fertility, deforestation, and detrimental nutrient and chemical emissions continue to rise at unacceptable levels. In many regions of the world 'mainstream' chemical agriculture continues on a pathway of self-destruction. Despite progress on the part of some countries, chronic undernourishment and hidden hunger, as well as obesity and other food related diseases have actually increased over the past decade. The destructive impact of industrial food systems and agricultural practices on our ecosystems and the social and cultural wellbeing of communities and nations has probably never been higher than today.

When looking back to the last decade we must acknowledge that, however intellectually and technologically productive and exciting it has been, it was by and large a lost decade for the practical resilience and ecological adaptation as suggested by the IAASTD report. While this is the statistically quantifiable evidence, the qualitative balance may not look as grim. This decade has seen bottom-up movements across the globe, not only demanding but realizing radical change, inspiring new approaches and practices in fields, kitchens and markets. A groundswell of highly innovative, yet conserving and healing agricultural and community practices may prove to have laid the ground for a "revolution of the niches" in industrialized as well as less industrialized societies.

Many scientists and other experts believe that the present decade will be the last chance to keep global warming and global biodiversity loss at an acceptable level for the survival of humankind. Likewise, bio-culturalism is threatened with irreversible collapse. The food and agricultural system has become the single most important factor that can deliver fast and sustained results in relation to these challenges. It is the one sector that directly affects, and can directly be influenced by, all those who eat and who produce food, i.e. all 7.7 billion humans on this planet.

Most societies and individuals now know exactly what needs to be changed, what really works and how it works. The financial and technical means to accomplish these changes are at hand. All that is needed is the political and economic will to do the right things at the right time. And there is clearly no time to lose.

Hopefully this collection of essays and topical papers will contribute to the debate, convincing and motivating colleagues, decision makers and all those involved in the food and agricultural sector to deliver the changes we all need to see. May it serve as a useful resource for those engaged in converting this paradigm shift into a real-life transformation of our food systems.

Endnotes

1 IAASTD, Global Summary for decision makers, p. 3

2 Kuhn, Thomas S., 1962,. The structure of scientific revolutions, 2nd edition 1970, p. 8

Benedikt Haerlin heads the Berlin office of the Foundation on Future Farming (Zukunftsstiftung Landwirtschaft). He co-ordinates the European initiative "Save our Seeds", runs a "global field" of 2000 m² and co-chairs the thinktank ARC2020 on European agricultural policies. He represented northern NGOs in the board of the IAASTD. Before, he was an author and journalist, a Member of the European Parliament and worked for Greenpeace International.

Marcia Ishii-Eiteman

IAASTD, agroecology and new ways forward

Amidst accelerating and converging health, climate, ecological, economic, financial and food system crises, the need to radically reconceive and change our approach to agriculture and even more fundamentally, our relationship to the earth, has become paramount. Just over a decade ago, the International Assessment for Agricultural Knowledge, Science and Technology for Development IAASTD began to move the global conversation in UN and other international policy circles in this direction.

Agroecology: paths towards equitable and sustainable food systems

With its publication in 2009, the IAASTD concluded that agroecology offers highly promising pathways to enable progress towards "equitable, socially, environmentally and economically sustainable development." These findings represent the results of analyses presented in the IAASTD's Global, Latin America and other regional reports (see box).

Agroecology in the IAASTD

Agroecology was addressed in unique ways by the Global and Regional Reports of the IAASTD. The Global Report (GR) reflected on the central role of Indigenous people, as well as subsequent interactions between farmers, researchers, scientists and civil society, in the development of agroecology, while noting its scientific and practice-based contributions to multifunctional agriculture, to innovation and knowledge generation, and to improving livelihoods and equity (GR chapters 2, 3 and 6). The Latin America & Caribbean report (LAC) discussed agroecology explicitly and in depth, recognizing its multiple dimensions that both draw on and contribute to a diversity of sciences, practices and social movements, with socio-economic, health, cultural, spiritual and political implications (LAC chapters 1, 2, 4 and 5). The North America & Europe report (NAE) focused on agroecology's scientific contributions to innovation (NAE chapter 6); the Sub-Saharan Africa report (SSA) addressed the practical benefits of applying agroecological methods to farming and pastoralism (SSA chapters 2, 3 and 5); and the East & South Asia and Pacific report (ESAP) pointed to the productivity and stability of "integrated and holistic agroecosystems" and agroecological practices that mimic natural systems, often rooted in Indigenous knowledge and able to reduce poverty and malnutrition, improve livelihoods, conserve biodiversity and offer an alternative to pesticide dependence (ESAP chapters 2, 3 and 5). Together, the IAASTD reports discussed a variety of policy options to build capacity in agroecology in the regions, while identifying measures to overcome systemic and structural obstacles impeding its spread.

The IAASTD discussed agroecology primarily in terms of its scientific and practical dimensions (McIntyre et al. 2009a-d), while also recognizing that agroecology "stems from the interaction of scientific and traditional knowledge," rooted in profound respect for the environment and Mother Earth, "as well as [people's] traditions, culture and history" (McIntyre et al. 2009e). As a movement, agroecology has the ability to join others – food sovereignty, Indigeneity (Figueroa-Helland et al. 2018) – in suggesting "a dialogue of different ways of knowing" (McIntyre et al. 2009e) that challenges assumptions behind dominant approaches to "development" (Mignolo 2020). Drawing on empirical evidence, the IAASTD found that agroecology contributes to:

- Increased ecological resilience and reduced risk in weathering changing climate and environmental conditions;
- Climate change mitigation and adaptation through reduced reliance on fossil fuel and fossil fuel-based agricultural inputs, increased carbon sequestration and water capture in soil;
- Conservation of biodiversity and natural resources and protection of ecosystem services;
- Improved health and nutrition by providing diverse, fresh and nutritious diets and reducing incidence of pesticide poisonings;
- Economic stability from diversified sources of income, a more even spread of labor requirements and production benefits over time and reduced vulnerability to commodity price swings and rising costs of purchased inputs; and
- Increased social resilience and institutional capacity, including shared knowledge and collectively managed economic and social support networks.

On a practical level, the IAASTD affirmed that agroecology inspires innovations that are knowledge-intensive, productive, profitable, culturally, socially and environmentally beneficial, and readily adaptable by small and medium-scale producers (McIntyre et al. 2009a-d, PANNA 2009). Meanwhile, social movements challenging entrenched power imbalances in food and agricultural systems have also perceived the emancipatory potential of agroecology, which frees producers from dependence on corporate-controlled inputs such as patented seeds and agrochemicals (McIntyre et al. 2009e).

Policy options to advance agroecology

The IAASTD identified numerous concrete policies to promote agroecology and systems transformation. These include the following "options for action".

- Build capacity in agroecological research, extension and education: encourage farmer-to-farmer learning and horizontal collaboration among farmers, Indigenous peoples and scientists;
- Support small and medium-scale farmers and their organizations: strengthen community organizations' capacity to develop and adapt agroecology to meet local priorities, particularly for food, land, seeds, water, health, livelihood, self-

determination and the right to organise; center farmer and Indigenous leaders in national, regional and international decision-making processes;
• Establish supportive economic policies, financial incentives and market opportunities to overcome structural barriers: evaluate and internalise the social, health and environmental costs of external input-intensive production systems; remove perverse incentives that continue dependence on hazardous inputs and industrial-scale monocropping; and incentivize ecological practices that provide public, environmental and ecosystem health benefits; and
• Strengthen institutional supports: implement comprehensive agrarian reform that ensures equitable and secure access to, control over and ownership of productive resources by peasant and small-scale farmers and Indigenous peoples; revise intellectual property rights to uphold farmers' rights to save, breed and exchange seed and disallow land, gene and water grabs by corporations; and establish equitable trade arrangements that enable farmers to meet their food and livelihood security needs.

Moving forward: agroecology after IAASTD

Both in terms of its substantive findings and the institutional innovation in multistakeholder governance that it introduced (Ishii-Eiteman 2009), the IAASTD set the stage for a decade of growing recognition in international policy circles of:

a) the need for transformative change of our food and agricultural systems;
b) a key role for agroecology in such a transformation;
c) the necessity to overcome entrenched structural obstacles to change; and
d) the imperative to center the knowledge, participation and leadership of frontline, peasant and Indigenous communities in moving towards systems transformations.

The contribution of agroecology to the pluriverse of solutions needed to overcome today's crises and its alignment with values of reciprocity, harmony, equity and solidarity is increasingly recognized and valued by farmers, social and biophysical scientists, health professionals and sustainable economies and human rights experts alike (See Anderson & Anderson, page 169 and Wezel, page140 in this book). Alternative visions that build on these and other complementary notions have been well-articulated by proponents of buen vivir (and of sumak kawsay, suma qamaña, Ubuntu, swaraj and de-growth), who are already in many parts of the world enacting and embodying these new-old ways of being (Gonzales & Mignolo, page 157 in this book; Khothari et al. 2015).

Unsurprisingly, industries and governments with vested economic interests in maintaining corporate industrial models of agriculture have fiercely opposed these calls for transformation. Despite this resistance, agroecology has continued to gain momentum and recognition on the global stage, supported by far-sighted policymakers, an expanding body of scientific research and the knowledge, experience and determination of peasant and family farmers and Indigenous

peoples who are co-creating not only the agroecological but also the liberatory epistemic systems to nourish their communities and sustain life on the planet.

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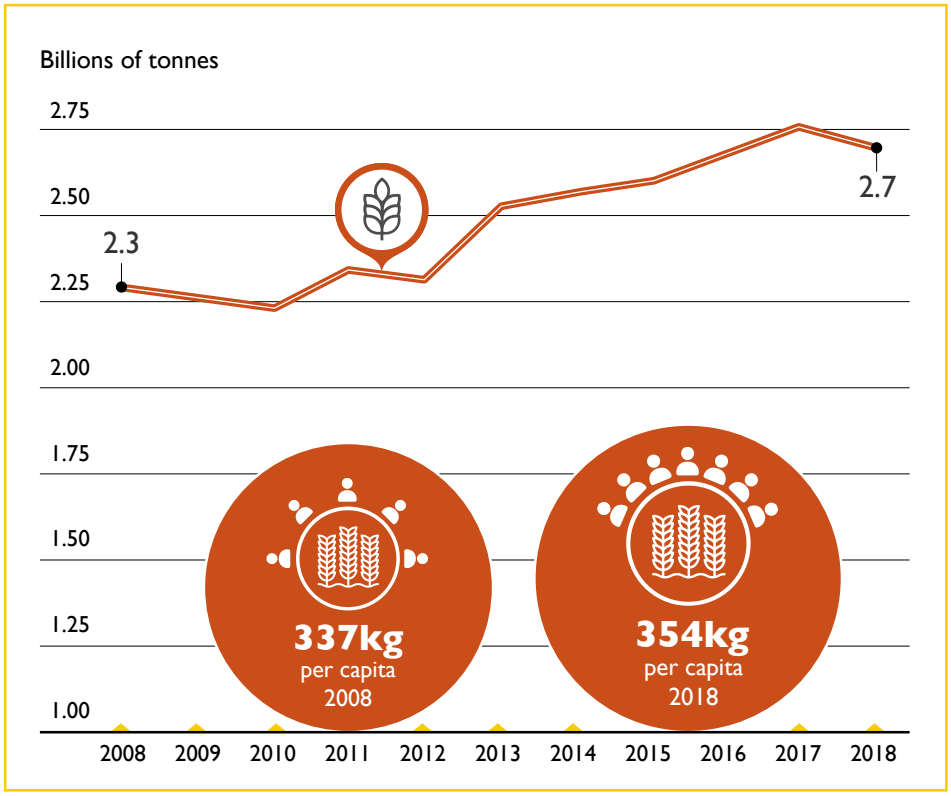
Cereal production



Global cereal production in billion tonnes (rice milled equivalent) and cereal production per person

Enough to feed us all

In 2018, 2.7 billion tonnes of cereals were produced worldwide, an increase of 18% compared to 2008. Production grew faster than the global population, reaching 354 kilograms per person in 2018. World cereal stocks amounted to 853 million tonnes in the same year, up from 510 million tonnes in 2008. There is enough food available to feed a growing world population.

Sources

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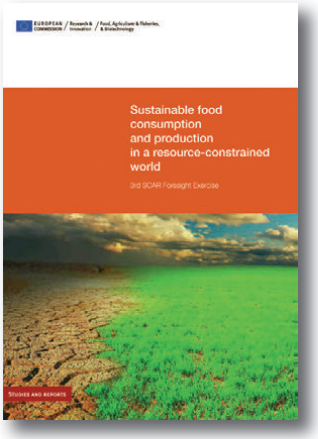
Erik Mathijs

Two narratives in a world of scarcities

In 2011, the EU Commission published the report "Sustainable Food Consumption and Production in a Resource-Constrained World".[1] It aimed to guide agricultural research in the EU to prepare for a smooth transition towards a world with resource constraints and environmental limits. The report identified a set of principles upon which our food system and agricultural research should be based.

The EU's Standing Committee on Agricultural Research (SCAR) is a body established in 1974 and relaunched in 2005 to provide advice to the European Commission and EU member states on the coordination of agricultural research in Europe. SCAR has a tradition of commissioning foresight exercises to support its recommendations. In 2010, a group of external experts were commissioned to carry out a foresight exercise for the committee that would provide the building blocks for longer-term perspectives to prepare the EU for a smooth transition towards a world with resource constraints and environmental limits. This resulted in the 3rd SCAR Foresight Exercise, published in 2011 (Freibauer et al., 2011), and revolved around three key concepts: scarcities, narratives and transition.



The report started by emphasizing that the changes taking place in the world create feedback effects that we poorly understand. Due to the interconnectedness of the combined scarcity challenges and the limited understanding of the feedback loops, the future is now more uncertain than ever. As ndicated by figure 1, interactions, in particular feedbacks, can further intensify, accelerate or change directions when several drivers are combined. These complex multiple interactions are critical for projections of global food security but unknown. These unknowns may pose a stronger and faster limit on global food production than any of the individual scarcities.

In addition, we were, and still are, ill-prepared to deal with such interconnected and highly dynamic issues. Due to the success of technological advances and substitution, the issue of resource scarcity has rarely featured on political or research agendas in recent decades. However, concerns about the availability of essential natural resources are now firmly back on worldwide agendas. These concerns have been further heightened by the emergence of 'new scarcities'

with respect to climate and biodiversity. A feature of today's concern is the attempt to understand the complexities surrounding these scarcities, which in themselves involve a number of different dimensions. The interactions between the different dimensions and between the different scarcities themselves, are key to finding a rationale and sustainable route forward. It is essential to ensure that decisions are made that are conducive to the emergence of a more sustainable world. Given that the 2008/9 financial crisis has turned into an enduring political crisis, the depth and scale of which is still taking shape, it is clear that the need for a global approach to sustainable resource use is increasingly at odds with the trend of protectionism and 'resource nationalism'.

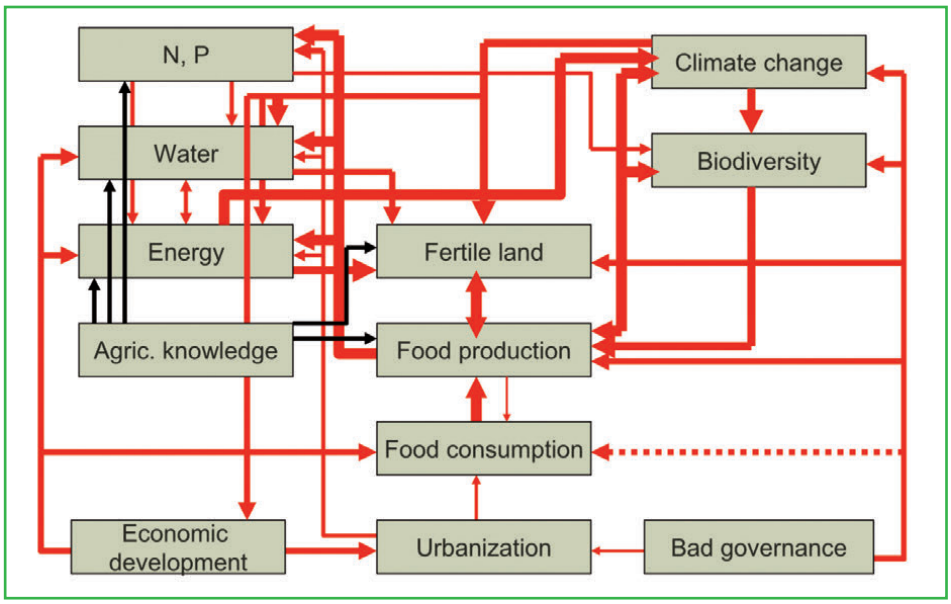


Figure 1: Scheme of interactions between scarcities. The size of the arrows indicates the intensity of the interactions. Arrows in both directions indicate complex, non-linear feedbacks. Source: Freibauer et al. (2011)

Next, echoing the messages of the IAASTD and others, the report brought to light that foresight studies and policy documents always use language or discourse that combines into a consistent storyline or narrative that reflects underlying worldviews and paradigms. These are sometimes made explicit, but are mostly implicit, particularly when the narrative reflects a dominant paradigm. Making these underlying worldviews explicit is a first step towards better understanding our possible futures. The danger of such narratives is that they are simplistic in that they do not capture the full complexity of underlying systems. The 3rd SCAR Foresight Exercise identified two main narratives that it used as lenses or perspectives that act as an entry point for analyzing scarcities and transitions.

The 3rd SCAR Foresight Exercise referred to the dominant narrative as the 'Productivity Narrative' and the alternative narrative as the 'Sufficiency Narrative'.

As authors we believed that these two concepts best summarized the underlying worldviews (*see box below for detailed explanation*). We emphasized that the two narratives represent extremes of a likely future pathway of agriculture and food. In reality it is expected that a mix of both extremes will be pursued and be necessary to deal with the diversity in trends, cultures and lifestyles.

The Productivity Narrative's main assumption is that economic growth is the only way forward for human development. Issues such as social inequality, resource scarcities and pollution are not ignored, but rather considered as constraints thus ignoring the underlying complexity of socio-ecological systems. Demand is considered to be exogenous, i.e., determined by external factors external to the agro-food system. The social impacts of new technologies, as reflected in intellectual property right issues and market power, are often underestimated. This narrative also includes the assumption that ecosystems are best preserved if the existing cropland areas are subject to massive intensification, in a way that can stop further extension of cropland into forests and other natural ecosystems. This assumption might seem correct when examining the global level of production, consumption and use of resources such as land, but when looking at the processes at stake, there is no evidence that intensification can lead to halting of the extension of cropland.

In the Sufficiency Narrative, demand is considered to be endogenous, i.e. part of the agro-food system and hence influenceable.

The Sufficiency Narrative's main assumption is that there are limits to growth imposed by the Earth's finite resources and finite assimilative capacity and by the vulnerability of its ecosystems that provide essential services to mankind. It believes that agro-ecological innovations and behavioural changes and changes in supply chains reducing demand are sufficient conditions to meet the world's food demand in 2050. Demand is considered to be endogenous, that is, part of the agro-food system and hence influenceable. However, economic, social and cultural barriers to a transition towards sufficiency are insufficiently taken into account by studies using this narrative. This narrative also contains an assumption that diversity is a better source of resilience, for the variety of systems considered: ecosystems and biodiversity, food patterns, markets, supply chains, agricultural production systems.

The effect of narratives can bear significant influence on policy and are in themselves generally not neutral. Resources (for instance for research) are often distributed according to the logic of the dominant narrative. The impact of this is that other perspectives – such as agro-ecology – have been given much less resources. In addition, many existing technologies have neglected important pieces of knowledge and retarded or prevented innovative solutions to emerging problems. Capacity building in some fields of research have to then be recreated from scratch, as in the field of agro-ecology. The report argues that research policies should give specific emphasis to building research capacity on ecosystem services that look at the ecological, social and economic conditions

The Productivity Narrative

The Challenge

World population will increase to an estimated 9.2 billion people in 2050, while agricultural productivity has been slowing down over the last decades. Rising income levels in emerging countries will shift diets to more protein rich food and will increase energy demand. Hence, there is a serious threat that food demand will not be met in 2050 leading to more hunger and political instability. In addition, resource constraints and climate change severely limit the world's capacity to expand food production.

The Solution

Scientific advances have the potential to bring forward new varieties, breeds and technologies that boost productivity and that at the same time take into account resource scarcities and environmental problems. To achieve this, massive investments need to be made in R&D, but also in the removal of barriers to adoption by farmers, such as infrastructure, trade barriers and access to markets.

The Sufficiency Narrative

The Challenge

World population will increase to an estimated 9.2 billion people in 2050, which will lead to dramatic environmental problems as system Earth does not have the capacity to support expected rates of consumption. In addition, current food systems produce waste, and overconsumption leads to mass health problems. The destruction of important ecosystems will have dramatic feedback effects that undermine the foundations of our food systems, leading to more poverty and conflict.

The Solution

Scientific advances have the potential to bring forward agro-ecosystems that are both productive, respectful for ecosystems and resource saving. However, to stay within the capacity of system Earth, demand increases need to be mitigated through behavioral change and structural changes in food systems and supply chains (among which food chain efficiency, reducing or re-using waste…), and environmental externalities need to be internalized in markets through appropriate governance structures that also address the disruptive effect of unregulated trade.

of production. At the same time, a much greater emphasis should be placed on socio-economic impact assessment of technologies, with specific reference to the impact on scarcities.

I now prefer to call these narratives the Efficiency and Sufficiency Narratives – in line with writers such as Wolfgang Sachs and Joseph Huber. While we presented the Efficiency and Sufficiency Narratives as extremes on a continuum, I now believe that we should consider them as necessary complements. In other words, efficiency is a necessary but not sufficient condition for sustainability and vice versa, sufficiency is a necessary but not sufficient condition for sustainability. We need both. This echoes the writings of the scholars mentioned earlier, but basically goes back to the Brundtland definition of sustainable development that combines the concept of needs with that of limitations.

1. Well-being: food and agricultural systems should serve the well-being and quality of life of all stakeholders involved: farmers and agribusiness should earn a sufficient income producing secure, safe and healthy food for consumers as well as public goods; fair access by all to a healthy food is critical for food security and well-being.

2. Resource use efficiency and optimality: given the increasing scarcities in vital resources, resources should be used as efficiently as possible (by avoiding waste, recycling and reducing our footprint), but they should also be used optimally, that is, where their contribution is greatest (by applying the cascading principle of resource contribution); this might imply radical changes in the way we look at the use of resources, shifting from an approach in terms of productivity to an approach in terms of sufficiency, where important changes in consumption patterns play an important role.

3. Resource conservation: to avoid the irreversible loss of natural resources, critical natural resources, including biodiversity, land and water should be maintained, taking into account the interaction between scarcities.

4. Diversity and inclusion: food and agricultural systems should reflect the territorial diversity present within the EU and worldwide; diversity may be instrumental for the resilience of our systems, but should also enhance the equitable access to affordable and healthy food and to natural resources.

5. Transdisciplinarity: research and innovation underpinning future food and agricultural systems should be truly interdisciplinary, that is, fully integrating the various sciences, including the social sciences and humanities, but be also transdisciplinary, that is, fully integrating the end user into research and innovation. Only in this way, the innovation gap between finding and adopting novelties can be overcome.

6. Experimentation: in order to develop the key breakthroughs needed to address the Grand Challenges of our time, research should be diverse, that is, ranging from blue sky research (fundamental research with no immediate applications) to applied research, but also based on different paradigms and narratives. Transdisciplinary research should have sufficient room for experimentation, not only in the technological realm, but also in the social.

7. Coordination and impact evaluation: research should be better coordinated across thematic domains as well as Member States. At the same research impacts should be better monitored and evaluated.

Generally, the operationalization of sufficiency involves product life extension, dematerialization and tertiarisation of products into services (the sharing economy, from ownership to use). Reichel (2016:24) argues that "…sufficiency is not just about producing and selling less physical products and having less ecological footprint; it first and foremost means to provide those kinds of products and services that enable consumers to live a lifestyle of sufficiency. It is all about re-

ducing energy and material use on the consumer side in an absolute manner, including prevention of the rebound effect".

While such an operationalization can be imagined when it comes to durable goods, mobility, housing, etc., the realization of sufficiency in food production is much more difficult, given the very transient nature of food. Sufficiency has been mainly interpreted as a demand restraint, particularly with respect to meat consumption. Less is more means eating less but higher quality meat. But also agro-ecology has the potential to address sufficiency, as its main driving force is equilibrium rather than growth. Taken at a higher level, this would require consumers to adapt their demand to the carrying capacity of the Earth.

Agroecology has the potential to address sufficiency, as its main driving force is equilibrium rather than growth.

To conclude, a radical change in food consumption and production in Europe is unavoidable to meet the challenges of scarcities and to make the agro-food system more resilient in times of increasing instability and surprise. The expert group compiled a set of principles upon which our food system in general and research concerning our agriculture and food system in particular should be based (see box 1).

Endnote

1 Available at: https://ec.europa.eu/research/scar/pdf/scar_3rd-foresight_2011.pdf

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Principles for more resilient food systems and future research priorities in the EU (from Freibauer et al. 2011, p. 185)

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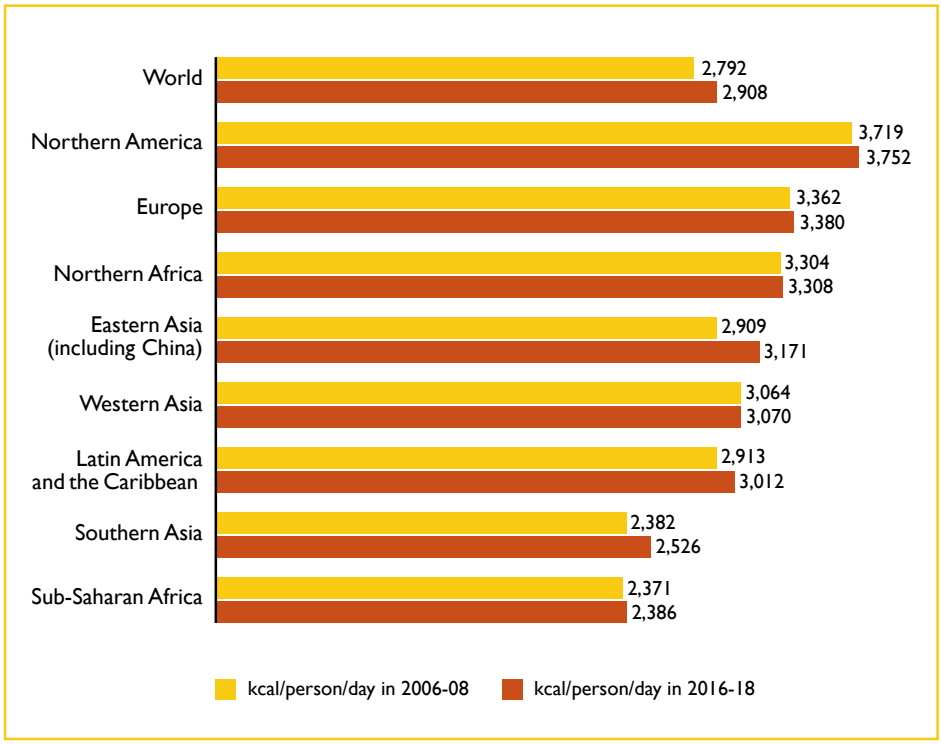
10-Year Comparison

Availability of calories



Per capita amount of energy (kcal) in food available for human consumption per day according to different world regions. The regional aggregates refer to a 3-year average period.

Counting the calories – regional disparities

In 2013, the world produced 5,935 kilocalories of crops per person per day that could be consumed by humans, and an additional 3,812 kcal of vegetable matter produced to be eaten by animals. The dietary energy supply – the food actually available for human consumption after taking out food waste and loss, non-food utilisation such as animal feed and industrial use as well as changes in stocks, is much lower. In 2016-18 a global average of 2,908 kcal were available for daily human consumption, up from 2,330 kcal fifty years earlier and 2,792 kcal ten years before. In Northern America, a record of 3,752 kcal/person/day were available in 2016-18 compared to 2,386 kcal in Sub-Saharan Africa. Increases over the past ten years were also unequally distributed: In Southern Asia calorie availability rose by 6%, whereas in Sub-Saharan Africa supply almost stagnated, rising by only 0.6%.

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Molly D. Anderson

Innovation for whom?

The need to transform the global food system could not be clearer as multiple reports over the past decade have illuminated the toll of greenhouse gas emissions from the food system, soil erosion and degradation, loss of biodiversity, and unjust compensation and conditions of work for farmers and farmworkers. The response from most businesses has not been encouraging, however. Rather than fundamentally change their business models, they have doubled down on minor modifications of their products and major investment in lobbying and attempting to influence public opinion. The "Innovation Principle" in the EU is a thinly veiled attempt to circumvent existing environmental and public health safeguards. It calls for a new kind of impact assessment to ensure that whenever policy or regulatory decisions are under consideration the impact on innovation as a driver for jobs and growth should be assessed and addressed (ERF, n.d.). Its supporters, the industry lobby group European Risk Forum, come mainly from chemical, fossil fuel and tobacco sectors – not renowned for their scrupulous attention to the public interest.

The EU "Innovation Principle" is a thinly veiled attempt to circumvent existing safeguards.

The World Economic Forum (WEF) and the IAASTD offer stark contrasts in the purpose of innovation. The IAASTD focused on impacts to smallholders who make up most of the world's food insecure people, as well as most of the farming population. For WEF (2018), the 'Transformative Twelve' innovations that could deliver significant impacts to food systems by 2030 include alternative proteins, nutrigenetics for personalized nutrition, "big data and advanced analytics for insurance", and "microbiome technologies to enhance crop resilience". It points to 80% of the poor people in the world living in rural areas and dependent on agriculture, but does not explain how the "transformative twelve" will help them. In fact, the beneficiaries seem to be the companies that come to Davos each year, including companies pushing the "Innovation Principle".

Innovation usually refers to new technology, even though social innovations (changes in policies, institutions, ownership regimes, knowledge) which encourage people to act in ways that promote conviviality and community show great promise to overcome barriers to cooperation and collaborative problem solving (e.g., Haxeltine et al., 2018). Why aren't we more wary of the glitter of modernity in food systems, given the many ways that "the modern" has backfired? The foods consumed in the typical "Western" diet lead to obesity, strokes, diabetes and even dementia. The excessive use of synthetic pesticides and fertilizers has

killed beneficial organisms and acidified soil so much that its productivity has plummeted. Reliance on fossil fuels in every food system activity is feeding the climate catastrophe. Yet each of these "innovations" was heralded as a breakthrough to greater yields and productivity when it first appeared.

If the rationale for an innovation is only increasing yields, productivity, profits or economic growth, it is likely to aggravate rather than ameliorate existing problems. The ten years since the publication of the IAASTD, during which neoliberalism as an economic system has metastasized, has shown that economic interests may cannibalize social and environmental goods and services. Articulating planetary boundaries, both environmental and social, has made clear that continuous economic growth is impossible. Societies must accommodate ecological constraints to keep the planet habitable for humans, and economic systems must accommodate the values set by a society in order to prevent rising inequity and discontent.

Those who have been hurt by the global food system should be included in decisions on new innovations.

How should an innovation be judged, to decide whether it is truly worthwhile in bringing society closer to justice, equitability and a healthy planet? The answer should be congruent with distributive, procedural and restorative justice; the EU's Innovation Principle does not mention justice of any type. But who decides which innovations are embraced and promoted, and how that decision is made are as important as the attributes of the innovation compared with the need it purportedly serves. Those who decide should include ones who have not benefited from, or who have been exploited and hurt by the global food system (e.g., slaves, low-paid wage-workers, farmers whose land has been stolen). Innovations should help to remedy damage to people and the natural environment, not simply lead to greater convenience or other benefits to those who are currently reaping benefits from the food system in the form of wealth or disproportionate access to healthy food.

Of course, holding innovation to such a standard requires an international or national body capable of evaluating the costs and benefits of inventions and capable of regulating inventions before they are released. To some extent, that is what environmental and health agencies are doing or supposed to do, but they are as fallible as the governments that create and fund them. For example, the US Environmental Protection Agency has rolled back at least 95 regulations aimed at protecting public lands, water and health under the Trump Administration (Popovich et al., 2019) and many countries lack the resources for environmental and health testing. Most often regulation will limit or impede business interests, not vice versa; and regulation within a country may be undermined by lobbying. A principle that promotes any "innovation" as long as it promotes jobs and growth (Quist et al., 2013) is only likely to perpetuate or exacerbate injustice.

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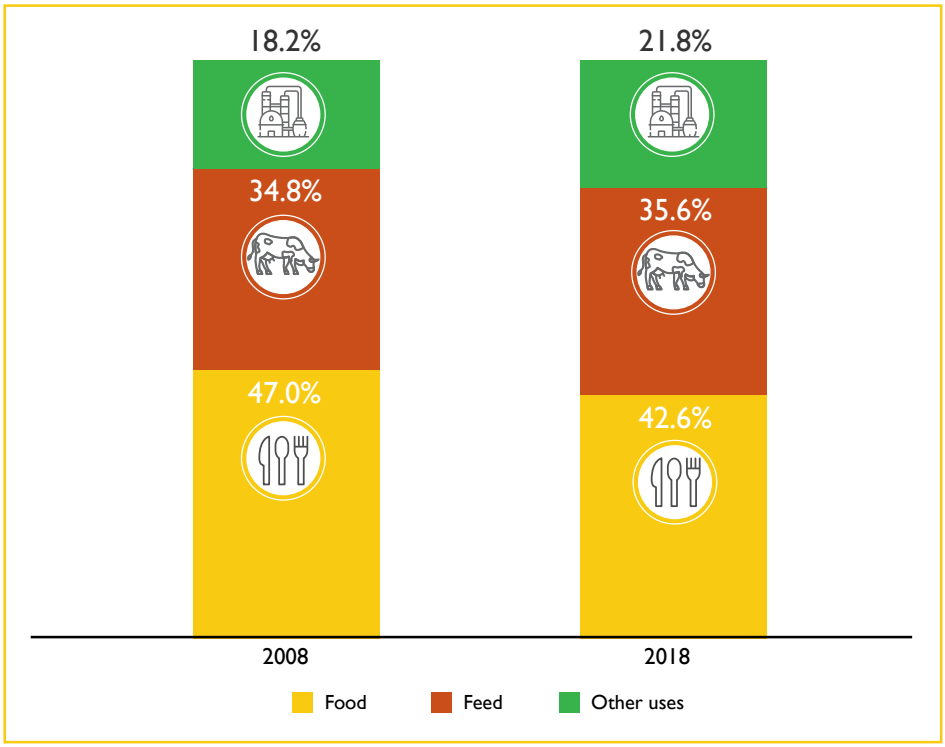
10-Year Comparison

Cereal utilisation



Utilisation of world cereal production (wheat, rice as milled equivalent and coarse grains) according to purpose of use.

Food, feed or fuel?

In 2018, total cereal utilisation amounted to 2.68 billion tonnes of cereal. Only 42.6% of wheat, rice and coarse grains were directly used as food for human consumption. The remainder was used as animal feed or for other purposes, such as the production of biofuels or other industrial uses. Twenty years ago, the share of cereals used for food consumption was still higher than 50%.

Sources

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Pat Mooney

Corporate multilateralism at the UN

IAASTD was wrapping up at an important but mostly unpredictable moment – the as-yet-unnamed Great Recession was ramping up, banks were begging, capitalism was quivering, and a food-price crisis was destabilizing countries and continents.

Corporate concentration all along the industrial food chain seemed contentedly oligopolistic – having gone as far as anyone thought regulators could tolerate and (thanks to joint ventures and cross-licensing arrangements) beyond anything the giants would need to beat back upstarts. Still licking their wounds from the GMO fiasco, Terminator Seeds had been rejected a second time and the smart money was hiding Climate-Smart in its data cloud. With Occupy hot after Wall Street there was even hope that State Street might screw up the nerve to take on the 1% or, at least, their companies.

At the first link in the Food Chain, Civil Society Organizations were rightfully railing that the six big Gene Giants with more than two thirds of the commercial seed and pesticide markets, should be broken up. But nobody thought further consolidation was possible. Though disenfranchised and demoralized, the public sector – both in research and regulation – seemed stabilized in servitude where the private sector wanted them. How the food system has changed! Here's a summary of six big changes we didn't prepare for:

1. The "Shock Doctrine" narrative: First, the UK's Stern Report and then the climate negotiations collapse in Copenhagen in 2009 set the stage for the so-called "Climate-Smart Agriculture" and a bold new agribusiness narrative. It's simple and persuasive: Faced with a growing population, increasing nutritional demands, climate change and biodiversity loss, agriculture will experience more change in the next few decades than it has in the last 10,000 years. Only Climate-Smart technologies can get us through this and only if governments clear the way for the big guns of corporate science to risk their investments and merge and converge as necessary. Naomi Klein laid out the corporate strategy in her 2006 book, "Shock Doctrine" – the same year as the Stern Report.

2. Frontal lobotomies – dumbing down governments: Governments (the Public Sector) have been moulding themselves to corporate need since Reagan and Thatcher but the last decade has witnessed a major stand-down in the capacity of many governments to monitor and regulate companies. Increasingly, public institutions and universities can't afford the equipment and can't compete for salaries to attract top-notch scientists, regulators and lawyers. With the brightest

minds and best tools in the hands of the biggest companies, the Public Sector has given itself a frontal lobotomy, surrendering its punitive power for a begging bowl. Not unique to agribusiness, this has most obviously played out in the aerospace industry with the Boeing 737max and with the ever-unfolding scandal around diesel car emissions, which has spread beyond Volkswagen to snare almost the entire automobile industry. On the food front, it plays out in government capacities to regulate chemical toxins (glyphosate et al.) and food safety (where health issues have multiplied as food inspectors have evaporated).

3. Apple or orchards? The Shock Doctrine narrative also applies to technology research strategies. Agribusiness argues that it takes vast amounts of money and squadrons of scientists to adapt agriculture to rapidly changing conditions. The argument is that the Public Sector and peasant producers have developed crops and livestock designed for local conditions – innovation/diversity "through space". The high-tech assumption is that the world needs innovation/diversity "through time", i.e. the highly-uniform crops and livestock we see around the world today can be adjusted year-by-year because of an ever-advancing product line that will also allow us to respond to climate change. It's Apple or orchard – buy a new iPhone every year and stay up-to-date or have an orchard full of diverse fruits that will make sure there is food on the table at harvest time. Centralized just-in-time corporate control or peasant-controlled flexible diversification. It's worth noting that just-in-time hasn't worked so well for Apple when its value chain encounters Covid-19 and can't access parts from around Asia.

With the World Food Systems Summit in 2021, for the first time in UN history, a summit has been managed and structured by the agrifood industry.

4. Alphabet scoop – covert capture: The big "ask" (demand?) with the new narrative is that anti-competition regulators step back and allow giant companies to become even bigger so that they can manage the risk involved in innovative research. In the past years, we've seen unprecedented mergers and acquisitions all along the food chain – takeovers we would never have believed 10 years ago. It is not simply that the six Gene Giants have become four (maybe, soon, three depending on the fate of Bayer/Monsanto and BASF's growing interests and possible new developments with Sinochem's takeover of ChemChina/Syngenta) but the real concern is that the new technology platforms – Big Data and AI – mean that the number one global farm machinery company, John Deere, might make a major move in the seed/pesticide sector or that Alphabet (Google's holding Co.) or Amazon (already owning Whole Foods and a growing array of brick-and-mortar stores) might bite into the Cloud Control of agricultural inputs or even food processing. At the end of the day, it may be the farm insurance companies that take over.

5. Stakeholders vs. steak eaters: Or, the ultimate takeovers may already be behind us since BlackRock, Vanguard and State Street, the world's three biggest asset managers, picked up shares in all of the major companies along all of the

links in the food chain. As Jennifer Clapp and her colleagues at the University of Waterloo have taught us, when Bayer, Monsanto, Dow, DuPont, Syngenta and BASF sat down to negotiate a couple of years ago, the only party that sat behind them and could see all of the cards on the table were the three asset managers. And, at the same time, they can look over at the other tables and see games being played by commodity traders and food processors. Multi-stakeholder dialogues are a farce when smallholder producers, the real stakeholders, are forced to shadowbox with the asset managers, the steak eaters, behind the biggest governments and corporations.

6. R&D vs. PR The final major development since the IAASTD has been the acceleration of agribusiness propaganda – the trend away from R&D in favour of PR. For the Shock Doctrine narrative to work, governments and the public have to believe that the agrifood industry is truly capable of solving our problems, that they "get" their social responsibilities and understand that their business has to change. This means that the input companies must promise to reduce the environmental damage of most pesticides and fertilizers. This also means that John Deere is committed to food security not data monopoly. This also means that food processors like Unilever and Nestlé will reduce packaging and eliminate non-reusable plastics. The problem – especially with R&D – is that it really is high risk and expensive whereas money spent on PR always yields returns. The reality is that the demand for plastics has never been greater and is projected to become greater still. For all their talk, the big processors of palm oil admit that they still can't stop buying the illegal products of burned-down forests and slave labour; that despite their commitments, the handful of chocolate manufacturers confess that child labour and slavery on cocoa farms is increasing.

The new multilateralism: All of these developments are facilitated by the corporate pressure for a new relationship between States and corporations. Championed by the World Economic Forum, companies are arguing that the world needs a new form of multilateralism that allows the corporate CEO and the State CEO to negotiate as equals. Officially, of course, they call for the participation of the world's biggest – and most compromised – aid and environment NGOs, in-house unions and domesticated producer organizations but these are welcomed as the cheerleaders in the background not as negotiators at the table. This is nowhere been more evident than in Davos' insistence that the UN Secretary-General convene a World Food Systems Summit in the final quarter of 2021. For the first time in UN history, a Summit has been managed and structured by the agrifood industry. We've never needed another IAASTD more.

In 1997, Pat Mooney co-founded the Rural Advancement Fund International (renamed ETC Group in 2001). He received the Right Livelihood Award in 1985 and the Pearson Peace Prize in 1998. He (co-)authored several books on the politics of biotechnology and biodiversity. ETC's work emphasizes plant genetic resources, agricultural biodiversity, and biotechnology.

Ulrich Hoffmann

How to cope with largely dysfunctional market signals for sustainable agriculture?

In 2013, the UN Conference on Trade and Development (UNCTAD) published the report "Wake up before it is too late: Make agriculture truly sustainable now for food security in a changing climate".[1] The report pointed out that the world needs a paradigm shift in agricultural development: from a "green revolution" to an "ecological intensification" approach. This implies a need for a rapid and significant shift towards a mosaic of sustainable, regenerative production systems that in turn considerably improve the productivity of small-scale farmers.

The UNCTAD report emphasized that a move is needed from a linear to a holistic approach in agricultural management; one which recognizes that a farmer is not only a producer of agricultural goods, but also a manager of an agro-ecological system, providing a significant number of public goods and services. The required transformation is much more profound than simply tweaking the existing industrial agricultural system. Rather, what is called for is a better understanding of the multi-functionality of agriculture, its pivotal importance for pro-poor rural development and the significant role it can play both in dealing with resource scarcities and in mitigating and adapting to climate change.

Climate change has the potential to irreversibly damage the natural resource base on which agriculture depends, with grave consequences for food security but also for the economic development of a large number of developing countries that significantly rely on agriculture. In these countries, agriculture accounts for more than two-thirds of total production and employs, directly or indirectly, the majority of the population. Therefore, meeting the dual challenge of achieving food security and mitigating and adapting to climate change requires urgent action for a fundamental and fast transformation of agriculture. In fact, time is becoming the most important scarcity factor in dealing with climate change.

This IAASTD+10 report provides plenty of examples of giving up external-input and pollution-intensive industrial agriculture and adopting agro-ecological and more socially inclusive and equitable production practices. These examples undoubtedly show that transition can work and, on a limited scale, is already happening. But these harbingers of transition cannot thrive without societal support, nor be uncoupled from an analysis of the bigger economic and policy issues necessary to send the right signals and create incentives for farmers and customers alike.

One of the main causes of slow progress is the lack of economic incentives.

The pressure for action for a fundamental transformation of our agro-food system is very high, but there is a clear lack of adequate and effective behavioral change of farmers. This is despite the fact that suitable truly sustainable production methods, management approaches and techniques are well known, readily available and, under certain conditions, economically viable even under the current economic framework.[2] As the UNCTAD Trade and Environment Review 2013 pointed out, however, the sheer scale at which modified production methods would have to be adopted, the significant governance issues, the power asymmetry problems in food input and output markets as well as the current international trade rules for agriculture pose considerable challenges.

One of the main causal factors for inaction or slow progress is the lack of economic, and to some extent cultural, incentives for applying reproductive agricultural practices. There are virtually no market mechanisms for agricultural production that encourage ecosystem and reproductive agricultural and soil management.

Farming is the most significant human management system of the planet. Farmed landscapes account for more than half of the terrestrial area of our planet and even a bigger share of its biological production.[3] In other words, human existence on the planet largely rests upon how we manage our farmland and soils. This has important implications for agricultural policies, because it means that managing farmland, soils and ecosystems is almost as important as producing agri-food products. But farmers are not encouraged by market signals and mechanisms to be land, groundwater, soil and biodiversity stewards. On the contrary, modern day farming has removed much of the land husbandry and stewardship that was previously an integral part of a regenerative farming system.

The monetary value of agricultural ecosystem services is estimated to be much higher than the total value of agricultural production.

Prevailing market forces encourage agricultural production that is entirely modeled after the industrial recipe, with a mechanistic view of nature and a linear external-input-intensive production approach, largely removed from its ecological and location-specific context. The model consciously and knowingly disconnects or violates ecological rules believing that the inevitable collateral damage will be taken care of by

other technological interventions and remedies, from which other industries again profit. Globalization has reinforced competition and has globally turned the role of the food system into a mechanism that transforms synthetic fertilizers via crop plants into nutrients for people (and animals) in the cheapest way.

Today, productivity is measured by how many tons of soybean or maize kernels a harvester combine can extract from a hectare of land. But as natural resources dwindle, the real productivity lies in how these resources re-generate. A productive system is one where there is more forest the next year than the year before, where there are more fish and if the soil becomes more fertile each year instead of becoming exhausted and eroded. Similarly, we are more productive if the food we produce and consume is healthy rather than just cheap. This is the rationale for defining the term 'integral productivity', combining the economic with social, cultural, health and ecological components.[4]

While many observers recognize the urgent need for transformation, too much hope is pinned on the potential of modern techno-fixes to mitigate the effects of resource-mining agriculture. There is no doubt that some new technological developments can reduce the environmental impact of industrial agriculture. But the danger is that a reliance on such fixes simply slows down the deployment of real solutions, thus prolonging our trajectory towards resource mining. In addition transformation will require a change of the incentive structure and thus the related market signals.

The most powerful mechanism for change would be the removal of energy subsidies.

There are almost no market mechanisms in place for undertaking the important task of managing the agriculture landscape and the resource base for farming, and currently there is a limited potential for such mechanisms to emerge. Even if they did they might never reach the extent required, considering that the value of agricultural ecosystem services is estimated to be much higher than the total value of agricultural production and even global GDP.[5] At present the market is still driving farmers the other way, into more and more specialization and monocultures and less stewardship of natural resources.[6]

Against this background, for decades many scholars have pointed to the need for internalization of the social and environmental costs and compensation for ecosystem services as the silver bullet for overcoming market failure and ill-conceived economic incentives for farmers. This would however require very extensive and complex regulation and government intervention. Such mechanisms have been proposed for more than half a century and very little progress has been made so far.

There are a number of examples of national programs for rewarding farmers for generating environmental services, but their results are mixed and potential systemic problems underestimated. For example, as early as 1996, Costa Rica introduced a system which rewarded landowners for carbon sequestration, bio-

diversity protection, water regulation and conserving landscapes. In 2001, the payments under this program had reached US$30 million and covered a total of 280,000 hectares (around 6% of the country's land mass). The payments thus amounted to about US$ 107 per ha per year.[7] Farmers in the Scoltel Té project in Chiapas in Mexico also sell carbon sequestration in the soil and in vegetation for between US$300 and 1,800 per farm, big sums for households where the average income is about US$1,000.[8] In 2003 more than 10% of England's agricultural land was enrolled in long-term contracts between the government and farmers to provide environmental services. There was a high uptake of the elements of the programs that didn't require fundamental changes to farming practices. But, in intensively farmed areas the uptake was low, as the incentives were not sufficient to persuade farmers to make more demanding changes. In a sense the program was just 'greening the edges'.[9]

There are many other potential problems with payments for ecosystem services, some of which are not initially seen. It also means that more ecosystems are 'commodified' and integrated in the global economy. This could lead to a new frontier of exploitation, where rich countries use land in developing countries as a 'dumping' ground for their waste, e.g. by paying for climate compensation to allow continued emissions in the industrial countries.

In the light of the conceptual considerations listed above and the undoubted level of urgency, most fruitful and likely to encourage interest amongst farmers is to roll out one or two powerful mechanisms that would serve to change the entire incentive structure - rather than the far tougher challenge of conceiving famers to embrace a fully different system. The most powerful measure one should consider in this regard is the removal of energy subsidies.

Higher costs for energy will then cascade through the system and make things that today seem 'efficient' and 'rational' appear like lunacy and completely irrational. Consequently, many of the fallacies of today's system will automatically disappear, in particular production systems based on external-input-dependent, highly specialized production, mass transport of food and cold chains for fresh convenience foods. The consequent 'freed' financial means from reduced energy subsidies can then be redirected towards compensating (or rather rewarding) farmers for providing environmental goods and services, bearing in mind the limitations listed above. An example of this compensation would be incentives for carbon sequestration in soils, which would increase soil fertility, mitigate climate change, arrest soil erosion, and encourage farmers to implement other regenerative agriculture practices.

Another key hurdle for agricultural transformation is the lack of political will to limit or correct the power asymmetries in international food supply chains through competition or anti-trust regulation. Farmers are therefore autonomously seizing the opportunity to sever the links with their classical markets, which are now dominated by large food processors, traders and retailers.[10]

Producer groups or cooperatives may develop various forms of community-supported agriculture, where, on the one hand, producers market their produce directly without intermediaries, thus profiting from higher prices and lower costs,[11] and, on the other hand, consumers take a stake or invest in farming. While monetary transaction may still be important in such systems they are in fact built on relationships rather than an anonymous market. Such approaches allow farmers to put much more emphasis on the qualitative and reproductive aspects of production, including soil fertility, and largely protect themselves from the treadmill pressure of mass commodity production. In addition, it may offer consumers – or citizens – a much needed way of reconnecting with food production. That will motivate them to support local production as well as policies directed towards regenerative agriculture.

Policy makers at local and community level can support such a development by a host of policy measures, such as changes in land planning and public procurement. In several countries, municipalities have become members of community-supported farms and purchase vegetables, fruit and sometimes meat for schools directly from farms. Territorial food initiatives that address sustainability problems and reinject democracy into food systems have also been rolled out, including the use of 'food policy councils'[12], and through other kinds of incentives that include free space for farmers' markets and making public land available on favorable terms.

To conclude, public awareness and pressure for a far-reaching transformation of agriculture and related food systems have undoubtedly increased considerably in recent years. This pressure has shown itself in support for initiatives like the Fridays for Future campaigns and public outrage over nitrogen contamination of soil and ground water and related industrial livestock production. However, with very few exceptions, political will and economic incentives on truly sustainable transformation of agriculture remain largely insufficient. Most political and market signals go in an opposite direction, mislabeled as 'green deals' or 'climate-smart agriculture' that still emphasize techno-fixes in order to avoid any deep-rooted socio-economic (and truly ecological) transformation of agriculture and food systems.[13] In this way, resource erosion and environmental destruction in agriculture are unlikely to be significantly slowed down, let alone stopped and reversed. In fact, the current situation resembles that of the fight for climate change mitigation in general: A spate of positive practical examples on greenhouse gas reduction opportunities and a large body of knowledge on the catastrophic consequences of likely temperature increases of 3-4 degrees or even more are apparently insufficient to alter the current greenhouse gas intensive, GDP-growth-fetishizing development paradigm. It seems as if true transformational change can only be triggered as a result of recurrent natural catastrophes and related human and development crisis situations, such as the recent massive bushfires in Australia – change by disaster, rather than transformation by design – a very sober bottom line.

Endnotes

1 Available at: https://unctad.org/en/pages/PublicationWebflyer.aspx?publicationid=6662

2 See also Abrecht S., Fuchs N., Hoffmann U. (2018). Agricultural Transformation Review (Vol.1): Soil stewardship reinvented. Issued by the Federation of German Scientists, Berlin. Available at: https://ag-trans-review.org/ and Van der Ploeg, J. D. (2009). The New Peasantries: Struggles for Autonomy and Sustainability in an Era of Empire and Globalization. Earthscan Publications.

3 For a more elaborate analysis see: Rundgren, G. (2015). Global Eating Disorder, Regeneration, Uppsala, p. 121 ff.

4 Haerlin B., Fuchs, N., Willing O. (2018). Für einen integralen Produktivitätsbegriff und eine selbstbewusste Biobewegung. Ein Diskussionsbeitrag der Zukunftsstiftung Landwirtschaft in der GLS Treuhand zum Thema „Bio 3.0", Bochum, Germany. Available at: www.zukunftsstiftung-landwirtschaft.de /media/Dokumente_Aktuelle_Meldungen/ZSL_zu_bio_3_0_11Pkt.pdf

5 The monetary value of nature's services is estimated by several studies as high as some $125-145 trillion for the year 2007 – that is two or three times higher than the annual global GDP, estimated at $55 trillion (Constanza, R., De Groot, R., Sutton, P., Van der Ploeg, S., Anderson, S.J., Kubiszewski, I., Farber, S., Turner, R.K., 2014. Changes in the global value of ecosystem services. Global Environmental Change, Vol. 26, pp. 152-158 as well as The Economics of Ecosystems and Biodiversity (TEEB) (2018). Measuring what matters in agriculture and food systems: a synthesis of the results and recommendations of TEEB for Agriculture and Food's Scientific and Economic Foundations report. UN Environment, Geneva. Available at: http://www.teebweb.org/publication/measuring-what-matters-in-agriculture-and-food-systems-a-synthesis/).

6 Historically unprecedented low interest rates in most developed countries have recently boosted investment in acquisition of farmland in expectation of speculative gains. This has contributed to significant increases in farmland prices. One would expect that higher land prices would encourage land/resource stewardship, but actually they increased the pressure on productivity and profitability improvements further expanding, for instance, the production of flexi-monocrops such as maize or soy beans for feed, food and fuel.

7 FAO (2007). The State of Food and Agriculture 2007. Rome. Available at: http://www.fao.org/3/a-a1200e.pdf

8 World Bank (2008). World Development Report 2008. Washington, D.C. Available at: http://documents.worldbank.org/curated/en/587251468175472382/pdf/41455optmzd0PA180821368077O1PUBLIC1.pdf

9 Dobbs, T.L. and J. Pretty 2008. Case study of agri-environmental payments: The United Kingdom. Ecological Economics 65, pp. 765-775.

10 Whereas in many developing countries direct marketing by peasant farmers is by far still the most important selling track, in the European Union only about 2% of the total volume of fresh food is sold directly from producers to consumers (European Commission (2015). You are part of the food chain: Key facts and figures on the food supply chain in the European Union. EU Agricultural Markets Briefs, No. 4. Available at: https://ec.europa.eu/agriculture/sites/agriculture/files/markets-and-prices/market-briefs/pdf/04_en.pdf).

11 It is estimated that buying from independent shops generates about 2.5 times as much local income as buying from supermarkets, because local shops also tend to buy local services (Transition Town Totnes, 2012. Economic Blueprint for Totnes & District: Our local food economy. Transition Town Totnes).

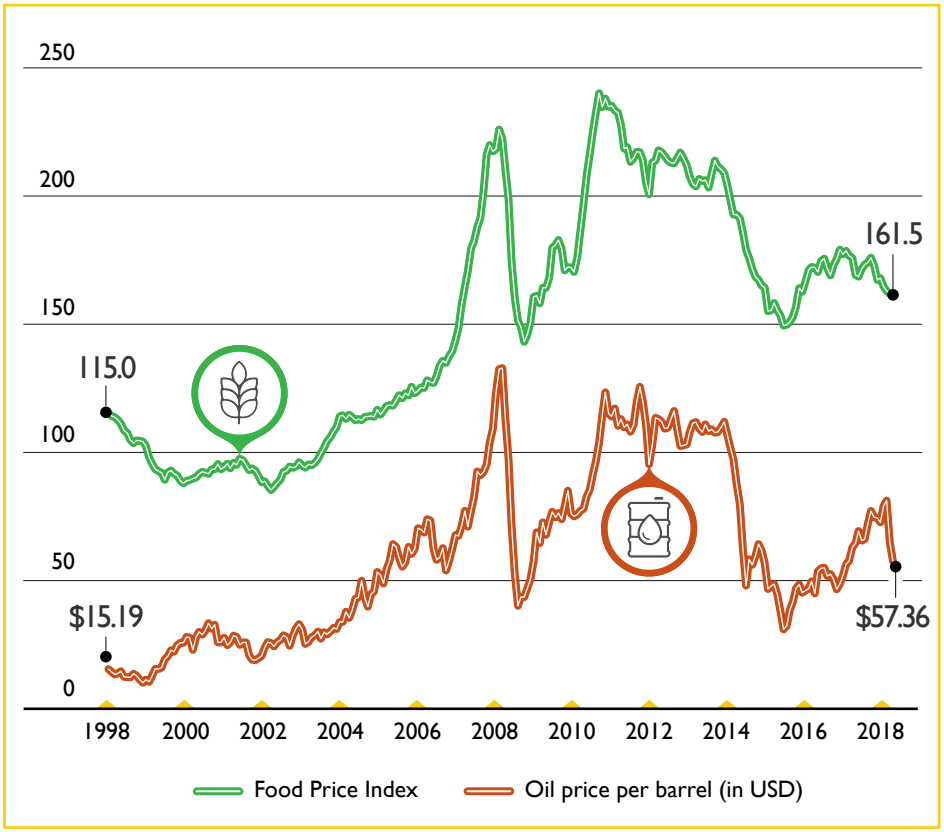
12 For more information in this regard see: International Panel of Experts on Sustainable Food Systems (2019). Towards a common food policy for the European Union. Brussels, pp. 87-88. Available at: http://www.ipes-food.org/_img/upload/files/CFP_FullReport.pdf

13 It remains to be seen whether the new "Farm to Fork initiative on a fair, healthy and environmentally friendly food system" as part of the new European Green Deal will really trigger far-going transformations on the ground.

Ulrich Hoffmann, a German economist, had a chair on trade and international financial relations at the Institute on Economics for Developing Countries in Berlin before joining the UN secretariat in the mid-1980s. He worked for the secretariat of the UN Conference on Trade and Environment (UNCTAD) in Geneva, focusing on production and trade of commodities, issues of sustainable resource management, and the transformation of agriculture. For many years, he was principal editor of one of UNCTAD's flagship publications: Trade and Environment Review. After retiring from UNCTAD in 2015 he was a senior associate at the Research Institute on Organic Agriculture (FiBL) and the International Institute for Sustainable Development (IISD).

20-Year Comparison

Oil and food prices



Price fluctuations for a barrel of Brent crude oil (in US dollars) and for food commodities (Food Price Index in points). This index measures monthly changes in international prices of a basket of food commodities (cereals, oilseeds, dairy products, meat and sugar).

Oil and food prices dance in tune

The price of crude oil and food have developed almost in parallel since the turn of the millennium. This is due to the high energy input used in the production of agricultural commodities. Industrial agriculture is still heavily reliant on fossil fuel energy, e.g. for the manufacture of fertilisers and pesticides or for producing and running farm machinery. Fossil fuels are also used to process, package, distribute and prepare food. Today's food system is based on a mechanism that transforms fossil fuels, via crop plants, into calories for people. The recent oil price crash in reaction to the coronavirus pandemic also led to a decline in global food prices. In April 2020, the price of a barrel of oil fell to 18 US dollars, which was mirrored by the Food Price Index dropping to an average of 165.5 points, the lowest level since January 2019.

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2 FAO (2020). FAO Food Price Index. Monthly Food Price Indices (2002-2004=100). http://www.fao.org/worldfoodsituation/foodpricesindex/en/

Steve Suppan

Trade and market policy

The trade and domestic market policy options of the IAASTD Global Report were derived from a large review of economic and policy literature: e.g. "Agricultural policies in industrialized countries, including export subsidies, have reduced commodity prices and thus food import costs; however, this has undermined the development of the agricultural sector in developing countries, and thus agriculture's significant potential growth multiplier for the whole economy (Diaz-Bonilla et al., 2003). Reducing industrialized countries' trade distorting policies including subsidies is a priority, particularly for commodities such as sugar, groundnuts and cotton where developing countries compete" (Global Report, 453).

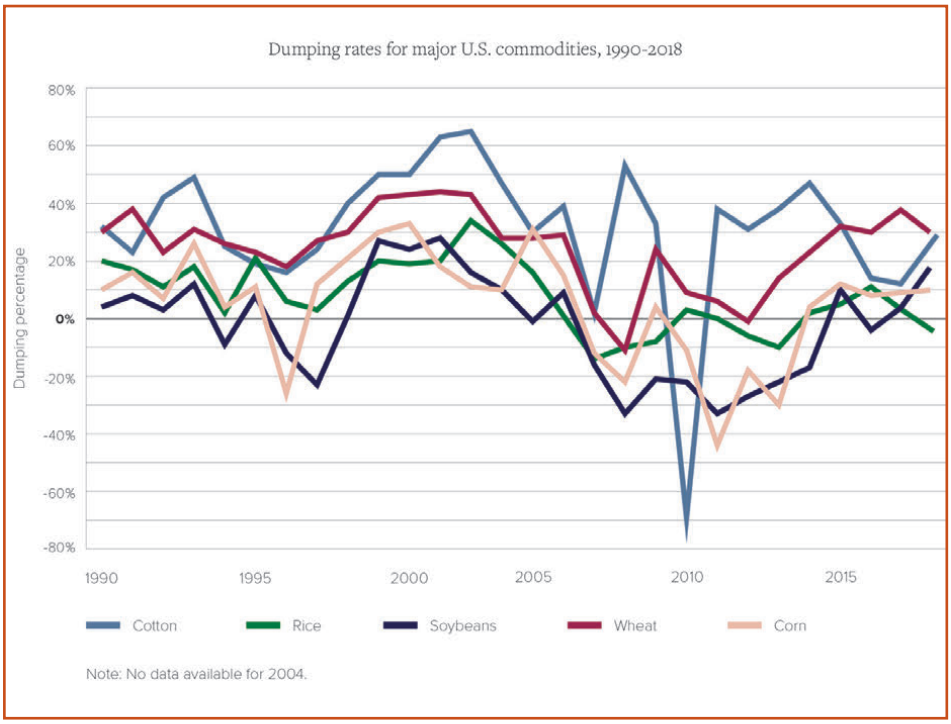
According to the South Centre's analysis of World Trade Organization (WTO) negotiations on agriculture subsidies, not only has there been no reduction in industrial country trade-distorting policy and subsidies, but the United States is unilaterally attacking what it claims to be trade distorting policy and subsidies in developing countries (South Centre, 2017). The deadlock on which agricultural subsidies and policy to allow is part of the current "existential crisis" of the WTO, which extends well beyond the current deadlock over the implementation of dispute settlement rules (Schott and Jung, 2019). Remarkably, there are still no rules in the WTO Agreement on Agriculture (AoA) to enable mitigation of or adaptation to climate change (FAO, 2018), which is unarguably a much greater "existential threat" to WTO members.

The deadlock on which agricultural subsidies to allow is part of the current WTO-crisis.

There is not even a clear consensus about how to measure subsidies. According to the OECD, Producer Support Estimates (PSEs) for agriculture has have been falling in OECD countries since 2000 and increased for 12 emerging economies (OECD 2019, Figure 1.4, at 49). However, PSEs do not estimate market price responsive subsidies, but rather OECD-defined specific forms of government support to producers. Because of methodological flaws in that calculation, such as the assumption that world prices are undistorted by anti-competitive business practices, PSE figures can drop for OECD countries while the subsidy portion of their PSE's rise. Conversely, PSE figures for developing countries can rise while their market price support drops (Wise, 2004).

The WTO adapted the PSE methodology and assumptions in the AoA Aggregate Measures of Support (AMS) to categorize government support that is decoupled from current product specific prices, and permitted "Green Box" support, e.g. pest and disease control. Product specific market price supporting

policies are put in an Amber Box of 'trade distorting' policies (WTO, 2003) while whole farm income insurance is deemed not trade distorting (Congressional Research Service, 2019). Indeed, because the AMS limits are so high for developed countries, it is possible for their agricultural exports to be AMS compliant even when they are sold at below the cost of production, an unfair and anti-competitive trading practice that the AoA does not discipline (Murphy and Hansen-Kuhn, 2019).



Calculations by Karen Hansen-Kuhn based on USDA Commodity Costs and Returns, OECD Producer Support Estimates and USDA Agricultural Marketing Services Grain Transportation Report Datasets.

There is a consistent trend of dumping of key U.S. agricultural goods, i.e., their sale at below the cost of production. In the chart above, the percentage of the price that is dumped is above the zero line. While this trend generally reversed when prices soared in 2008 and again in 2012, it has resumed for most crops since then, undermining farmers both in developing countries and the U.S.

There is no legal definition of "trade distortion" in the AoA, but an economic definition can be inferred from the OECD viewpoint that "a large part of support for producers come from measures that create a gap between the domestic and world market prices" (OECD, 2019 at 23). Trade theory asserts that

there should be no gap, i.e. no government policy induced domestic price distortion deviating from the world prices for the globally traded commodities. World prices should be determined by transactions on the most price influential commodity exchanges. The transactions should 'discover' the futures contracts prices that are benchmarks for the Free on Board (FoB) prices for agricultural commodities (Balasubramaraniam, 2020).
However, in reality, as financial institutions have become dominant in physical commodity futures markets, the historic role of futures prices as benchmarks for setting domestic forward prices, e.g. at grain elevators, and subsequently FoB prices, has become less reliable (UNCTAD 2011). For example, the failure of wheat futures to converge with cash prices at the expiration of the futures contract meant that the futures price did not serve as a reliable benchmark for forward contracting. The Chicago Mercantile Exchange explains convergence failure as a problem of wheat contract design, rather than the dominance of the wheat contract by financial actors (Suppan, 2019).

Attempts to regulate the participation of financial actors have been defeated by lobbying, litigation and defunding of regulatory agencies.

Attempts to regulate the participation of financial actors with no or only highly attenuated connection to the processing, merchandising or use of physical commodities have been defeated by lobbying, litigation and defunding of regulatory agencies, e.g. in the proposed speculative position limits rule of the U.S. Commodity Futures Trading Commission. As a result, U.S. commodity futures markets and market participants, the most globally price influential for many commodities, are de facto or de jure largely "self-regulated" (Gibbon, 2013).

In the World Bank's theory and research, "sustained deviation of domestic prices from world prices in either direction leads to substantially sub-optimal outcomes and slows the rate of economic growth; and (…) as international food prices reflect global scarcity or surplus, their transmission to domestic prices can help improve the global responsiveness of the food system to shocks" (Zorya, Townsend and Delgado, 2012). If world commodity prices were not themselves subject to price distortion by financial actors and anti-competitive business practices, then the World Bank loan and policy conditionalities might provide development country policy makers with useful advice. But to the extent that international food prices do not simply reflect global supply and scarcity, developing country policy makers may be better advised to guide domestic agricultural policy in accord with domestic price formation, rather than guide that policy according to international prices over which they have no influence in futures market trading.

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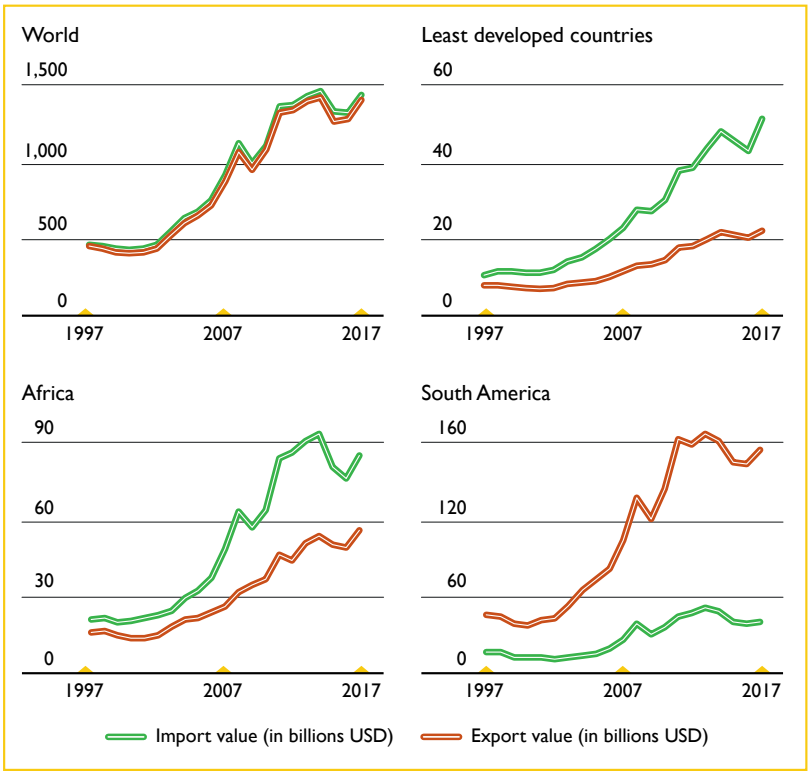
Agricultural imports and exports



Value of agricultural imports and exports of all countries worldwide combined, of the world's currently 47 least developed countries (LDCs), Africa and South America from 1997 to 2017 in billion US dollars

The world trade divide

The agricultural trade balance of many of the world's regions or country groups is unbalanced. Until 1980, the least developed countries (LDCs) still had an agricultural trade surplus, but by the turn of the millennium, imports were already twice as high as exports. Between 1997 and 2017, agricultural imports of LDCs increased by 555%. Africa ceased to be a net exporter in the early 1980s when prices of raw commodities such as coffee, cocoa and spices declined and domestic food production grew only slowly. Basic foodstuffs, such as cereals, dairy products and sugar, make up a large proportion of Africa's total food imports. A food-trade deficit can become a problem for poor countries lacking foreign currency reserves. In South America, the picture looks different. Between 1997 and 2017, agricultural exports almost quadrupled, leading to a trade surplus of $118 bn. Argentina and Brazil are among the world's largest exporters of wheat, maize, soybeans and sugar.

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Michael Bergöö & Mayumi Ridenhour

How the IAASTD helped shape the SDGs

In 2015, the international community agreed on 17 Sustainable Development Goals (SDGs)[1], to be achieved by 2030. The SDGs are a call for action by all countries to promote peace and prosperity while protecting the planet. SDG 2 is "Zero Hunger" and offers a historic opportunity to achieve a world with enough nutritious food for all that is produced by healthy people in a healthy environment.

As the gavel came down for the last time late on the evening of 2 August 2015, one of the most complex negotiations of recent times was brought to a successful end. On that evening, all 193 UN Member States agreed on 17 SDGs to end poverty, protect the planet, and improve the lives and prospects of everyone, everywhere. As part of the 2030 Agenda for Sustainable Development which set out a 15-year plan to achieve the goals, the SDGs provide an evidence-based holistic blueprint to the most pressing challenges of our time such as eradicating poverty, ending hunger, creating jobs, and ensuring access to healthcare and education, healthy ecosystems, and gender equality. In times of increased geopolitical tensions and a general weakening of multilateralism, bringing together more than 190 countries in one room to agree on an ambitious agenda to transform the world was momentous.

1. Navigating unchartered territory

The journey that concluded with overwhelming applause, relief, handshaking, and hugs among negotiators and observers that lush early-August evening, as well as a final document that was revealed at the official SDG Summit in September 2015, started for us in May 2013 in one of the monotonous conference rooms in the basement of the UN headquarters in New York City. On the agenda: An interactive exchange on "Food security and nutrition, sustainable agriculture, desertification, land degradation and drought."

This meeting presented the first opportunity to present some of the key findings and recommendations of the IAASTD to the Open Working Group (OWG), a 70 UN Member States body mandated to propose a set of SDGs to the UN

General Assembly. Hans R. Herren was invited to present on a panel, and we also organized an informal exchange with Member State delegates and observers to discuss what a food-related goal could potentially look like.

Even before we started, it was mostly agreed that issues such as malnutrition, women, and small-scale food producers would be prioritized. There seemed to be a consensus that they would be included in a food-related goal. However, it became apparent that many of the more complex and novel approaches and at the time rather progressive suggestions such as multifunctional agriculture or multi-stakeholder assessments of national food systems would require further refinement and many more hours of discussion.

It took thousands of coffees in the UN Vienna Café to ensure that important IAASTD messages made it into the SDGs.

In addition, it became apparent that for many Member States the entire concept of "sustainable development," firmly established in Stockholm in 1972 at the UN Conference on the Human Environment, was still unclear, especially now that they were asked to boil it down into a limited number of concrete global goals and targets. The Millennium Development Goals (MDGs), while groundbreaking, took a narrower approach that focused solely on developing countries and aimed to address the symptoms and not the root causes of poverty. Sustainable food systems are critical to achieving many development goals, from safe access to food to healthy ecosystems and even conflict resolution. However, the potential of sustainable food systems to combat global challenges that was recognized in the IAASTD was not taken up in the MDGs.

Finally, how to create a systemic plan of action with co-benefits between issues, such as between agriculture and climate change, land degradation or youth employment – to name a few – was not obvious to governments. They were still used to working in silos. Taking an integrated and systemic approach was new to many of them. With this context in mind, when the post-2015 negotiations started in spring 2013 it was not completely clear that there would be a goal on agriculture, and even less so that the goal would include "sustainable agriculture" in its title or make a reference to food systems.

2. Making progress – line by line and target by target

In order to avoid the status quo and ensure that the SDG that addressed hunger, food, and nutrition was truly transformative and would help establish the foundation for the paradigm shift necessary to achieve sustainable development, we recognized that we needed to educate Member States on the findings and recommendations of the IAASTD. We also realized that we had to be strategic in the way we suggested specific language to include in the positions and drafts coming out of these complex negotiations. What started during the May 2013 session of the OWG continued throughout many weeks of intense negotiations. To ensure that the important messages of the IAASTD were at the forefront

of discussions on what would become SDG 2, we attended all the OWG meetings and SDG negotiations as observers, organized several side-events to shed light on the many benefits of sustainable food systems, produced dozens of one-pagers and discussion papers with language suggestions and rationales, engaged in hundreds of bilateral meetings with negotiators, representatives of UN agencies and the secretariat, civil society, business and academia, and drank thousands of coffees in the infamous Vienna Cafe.

An important milestone in "translating" the comprehensive IAASTD into a concise goal and accompanying targets was a high-level multi-stakeholder roundtable that was co-hosted by the Government of Benin. Participation from high level representatives from governments, the UN System, research, civil society, farmers, and the private sector demonstrated the global importance and cross-cutting nature of this issue. The timing of this event was crucial since it was just prior to the end of the OWG, when the original proposal for the SDGs was finalized. At this roundtable, the SHIFT message emerged – echoing IAASTD's call for transformational change in agriculture and food systems. SHIFT stands for:

Small-scale food producers empowered;
Hunger and all forms of malnutrition ended, and full access to food ensured;
Inclusiveness in decision-making on sustainable agriculture, food security and nutrition;
Food systems established which are sustainable, diverse and resilient, less wasteful, restore soil fertility and halt land degradation;
Trade policies reshaped and food price volatility mitigated.

Most of the SHIFT elements made it into the SDGs (S, H, F and T), due to the outcome from this roundtable, as well as the efforts and perseverance of many Member State delegates and non-governmental actors.

The I from the SHIFT message was reflected in the inclusion of the reference of the Committee on World Food Security (CFS) in the Agenda 2030 Declaration (Paragraph 24). While many agriculture and food security experts were aware of the value added and expertise of the CFS, this was not immediately apparent to many of the negotiators. Therefore, efforts were successfully made to include language outlining the important role and inclusive nature of the CFS to support the achievement of SDG 2. This reference is very valuable since it establishes the CFS with its multi-stakeholder approach as instrumental in the implementation as well as the follow up and review of Agenda 2030, particularly those elements related to agriculture, food security, and nutrition. This recognition of the CFS also increases the likelihood that concepts from the IAASTD and agreed upon at the CFS (e.g. "sustainable food systems", and to a lesser extent "agroecology") will be accepted and supported in future sustainable development discussions

SDG 2 targets 2.3 & 2.4

2.3: By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment

2.4: By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality

that take place at the UN Headquarters in New York and beyond. One example of this occurring was in 2017 when "agroecological principles" were for the first time mentioned in a resolution by the UN General Assembly.

In order to promote the shift towards more sustainable food systems and ensure that the right language was included in the SDGs and Agenda 2030, we had to build awareness and widely disseminate our message. We quickly learned that the best way to be recognized and heard was to work in partnerships. We therefore approached various organizations to receive feedback on our positions, exchange valuable information about the issues and the process, and increase the credibility of our messages. In civil society circles, the findings of the IAASTD helped us to garner support and build a coalition around the key messages. We also collaborated with representatives from UN agencies, particularly the Rome-based agencies (FAO, WFP, and IFAD), well-established experts on issues around sustainable agriculture, food security and nutrition. This collaboration included key representatives from these agencies supporting and speaking at our side events. We also worked together with various partners on language to include in position statements.

3. Every word matters

While most of SDG 2 and its targets reaffirm the messages outlined in the IAASTD, targets 2.3 and 2.4 most closely reflect the findings and recommendations of the IAASTD. Although most Member States and stakeholders were in agreement that supporting small-scale food producers and promoting sustainable agriculture were important enough to include in the targets, it was not always clear how this would be done. At the end it was not only ensured that the targets included language that supported the IAASTD, but also excluded language that could slow down, halt or even reverse the change in course in global agriculture.

Looking more closely at Target 2.3, the focus on increasing the productivity and incomes of small-scale food producers, particularly women, and ensuring their access to productive resources and assets, clearly demonstrates that most Mem-

ber States recognized the potential of the millions of smallholder farmers around the world to lift their communities out of poverty while protecting the ecosystem. The strong wording in Target 2.3 clearly supports their empowerment and the improvement of their livelihoods.

Although most of the wording of this target was not very contentious, there were still calls from some Member States to not only increase agricultural productivity, but to increase production as well. This was something that was not in line with the IAASTD since there is evidence that an unqualified increase in production has had and would continue to have negative impacts on people (e.g. working conditions) and the planet (depletion of natural resources). Even though some Member States requested the inclusion of "increase production," this kind of detrimental language was prevented from being included in Target 2.3.

Under Target 2.4, we worked hard to ensure that it echoed the Rio+20 Declaration's call, in which we were already heavily involved with proposing IAASTD wording, for a much needed transformation to sustainable and resilient agriculture and food systems that conserve natural resources and ecosystems and realize a land-degradation neutral world. We were pleased to see that many of these elements are included in both Target 2.4 and also Target 15.3 ("(…) strive to achieve a land degradation-neutral world"). For example, the inclusion of resilient agricultural practices is significant since we cannot achieve sustainable development without ensuring that our food production adapts to the effects of climate change.

However, one obstacle we were not able to surmount was the reluctance by many Members States to agree on "sustainable food systems," a term and concept that applies to both the production and the consumption of food. In particular, emerging economies argued strongly for the qualifier "production" and a sole focus on the production side of food systems. This was because many of them were faced with a two-sided challenge: While they were still combatting hunger among some groups of their populations, they did not want to put (unnecessary) restrictions on how their emerging middle-class would consume food and emit greenhouse gases. Despite the fact that the exact language we wanted was not included in the final document, we still believe that this was a good starting point because the pressure to transform the way we produce and consume food globally continues.

4. IAASTD providing the narrative for SDG 2

Looking back on the lengthy and complex Agenda 2030 negotiations, it is hard to say precisely where, when, and how the IAASTD was instrumental in shaping the SDGs and in particular SDG 2 Zero Hunger. The process involved many actors – on a normal negotiation week there were several hundred representatives from Member States, UN agencies, civil society, business and academia present in- and outside the conference rooms. There were many firm positions – e.g. on agricultural trade it was impossible to make progress beyond what was agreed at the WTO. Also, the negotiations saw unexpected developments – for example, the two co-

chairs maintained control of the drafting throughout the negotiations, which was different from previous negotiations, for example in Rio+20. This was, in our view, one of the success factors that contributed to an ambitious set of SDGs. At one point, the discussions on the means of implementation (MOI) were partly shifted into the more politicized "Finance for Development" forum, which probably did not help to increase the ambition level on the MOI-targets. Given all these variables, it was not easy to secure IAASTD's specific messaging in negotiations that were at times chaotic and the attention of the Member States was elsewhere.

However, we can wholeheartedly say that the IAASTD provided us, our partners, and most importantly, negotiators with an invaluable source of evidence-based information and concepts, which we then tried to boil down to 2-liners and bring into the SDGs. Some elements never made it in (agroecology, food governance issues, the right to food) or were weakened at the last minute (sustainable food systems). From today's perspective, we might say that they may have just been ahead of their time. The IAASTD helped us connect the dots between issues that would not have been seen as an obvious interlinkage (e.g. food systems and stable institutions). It helped us and the negotiators to stay on course towards a coherent and ambitious SDG 2.

Throughout the process, we were reminded at various instances that the IAASTD – signed by 58 governments and called by some the IPCC of agriculture – was considered controversial in some circles, in particular among large-scale agriculture producers and proponents of GMOs. This sometimes forced us to omit the source of our rationales for change. But it did not prevent us from working hard to use Agenda 2030 as an opportunity to highlight IAASTD's call for a radical transformation. Because the IAASTD and the Agenda 2030 have something in common: they are both a transformative plan of action for people, planet and prosperity.

Endnote

1 https://www.un.org/sustainabledevelopment/

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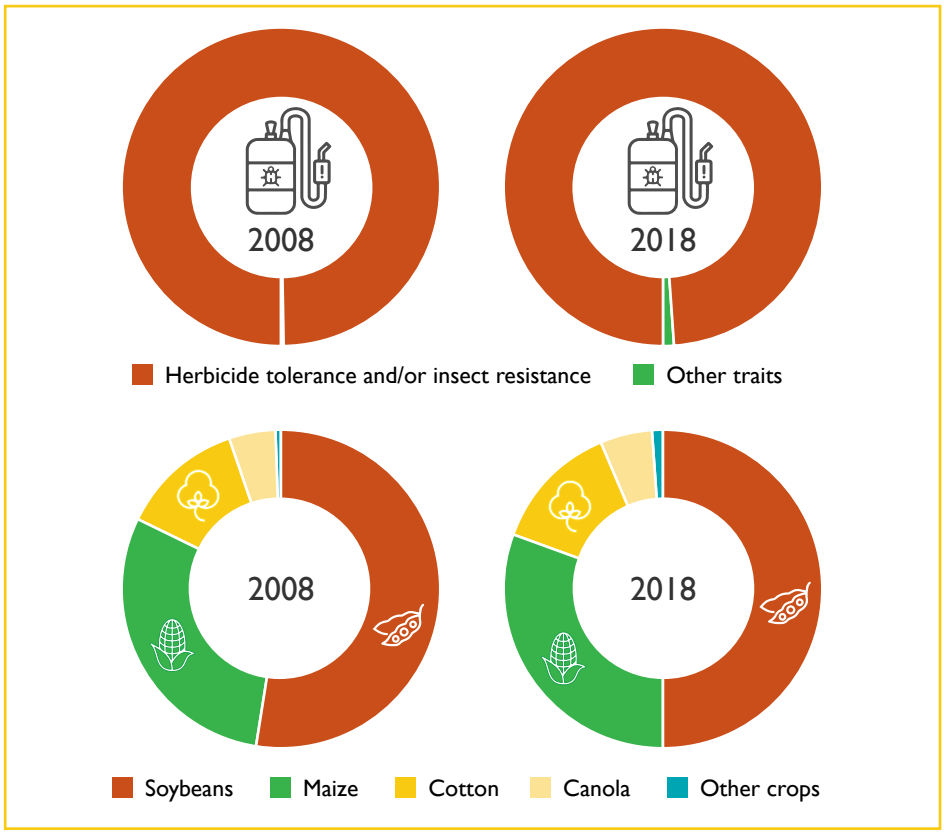
After working for the Swiss Humanitarian Aid in Liberia, Michael Bergöö joined Biovision Foundation in 2013 as Advocacy Manager during the post-2015 negotiations. He then joined the Executive Committee to expand Biovision's program in Switzerland and to initiate the Swiss chapter of the Sustainable Development Solutions Network (SDSN). Today Michael works for ClimateView – a Swedish software startup helping cities and countries achieving carbon neutrality. Michael holds a MA in political science from University of Lausanne.

GMOs: crops and traits



Global area of genetically modified crops in 2008 and 2018 by trait (above) and by crop type (below). Herbicide tolerance and/or insect resistance includes both single and stacked traits.

The same old story

Since their introduction in 1996, GMOs have been promoted as a panacea for tackling world hunger, malnutrition, poverty and drought. However, to date traits such as drought tolerance or enhanced provitamin A content have not yet been commercialised. Herbicide tolerance and insect resistance remain by far the dominant traits. In 2018, more than 99% of the 189.8 million hectares under cultivation with GMOs were planted with crops that were herbicide tolerant (45%), insect resistant (12%) or combined both traits (42%). The "Others" category includes a few hundred hectares of virus resistant papaya and squash. The cultivation of GM crops also remains limited to the same four crops: soybeans, maize, cotton and rapeseed. In 2018, 95.9 million hectares were planted with soybeans, followed by maize (58.9m ha), cotton (24.9m ha) and canola (10.1m ha).

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Angelika Hilbeck & Eugenio Tisselli

The emerging issue of "digitalization" of agriculture

When the IAASTD Report was written, digitalization of the agro-food sector was not yet on the 'transformation' agenda. While some digital and robotic tools were already being applied and tried in agriculture at that time (e.g. automated milking machines[1]), new digital possibilities had just begun to emerge. The fast and far reaching technological advances in the IT and telecom sector allowed the convergence of various business fields which rely on complex algorithms, data collection and storage, pervasive network access and constantly accelerating connection speeds.

Digitalization in conventional agriculture mostly aims to capture the global agro-food production system by radically automating and digitally connecting farming and processing operations and replacing humans, i.e. eliminating farmers. Although the projected increases in efficiency of the typical industrial inputs in conventional agriculture may materialize, the 'disruptive' power of this form of digitalization at all levels (agronomic, scientific, ecological, social, economic, cultural, etc.) remains underestimated and under-recognized. Since the publication of the IAASTD, the sheer unlimited possibilities for capture and disruption have begun to unfold – and with them the dystopian or utopian visions for the transformation of our future global agro-food systems. But as with all technology pushes, their potential risks and benefits depend entirely on the context of their application. Hence, the first and key question in any debate about digitalization of agriculture is: of which form of agriculture: conventional, industrial, ecological, traditional, all or some of these?

If digitalization is seen as a driver of agriculture, farmers become mere sources of raw material, i.e. data.

We do not offer here a systematic analysis of the various risks and consequences of digitalization in conventional, industrial forms of agriculture, but we wish to outline the critical aspects that must be considered in the digitalization of agroecological forms of farming. We believe that digitalization can be compatible with and support agroecological farming, yet it requires an entirely different approach from the one currently applied by the actors in conventional agriculture (see also Ajena 2018 for more details on this issue). In the following paragraphs, we briefly present a framework that delineates how key elements related to digitalization could be conceptualized in order to support agroecology. We align our contribution with five of the ten elements of agroecology identified by the Food and Agriculture Organisation (FAO) of the United Nations (UN). For each of these five elements, we contrast the different modes of digitalization in conventional versus agroecological systems.

1. One-size-fits-all versus integration of diversity

Conventional: Digital tools are marketed under the typical decontextualized top-down and 'one size fits all' formula, which fails to address diversity and context sensitivity, and seeks to enable 'disruptive business models based on data and platforms' (e.g. Bayer 2018 Example Crop Science: Outcome-based business models 'One size fits all'[2])

Agroecology: Avoiding the narrowness of single IT solutions by integrating diverse and appropriate ICT platforms and applications that are either already available or are developed in participatory fashion (see 2. below) and that are relevant in a specific context, favoring adaptation and interoperability.

2. Data mining versus sharing of knowledge

Conventional: Farmers are considered as clients of prepackaged, top-down 'solutions' by unknown 'expert' sources. These sources are often algorithms which mine and process large quantities of data related to and extracted from farming operations, to finally deliver statistical indicators which may or may not agree with a farmer's knowledge or experience and offer single (input) recipe solutions. If digitalization is considered as a driver of agriculture, farmers become mere sources of raw material, i.e. data, as well as algorithmically driven operators, thereby devaluing and endangering the continuity of their local and tacit knowledge.

Agroecology: Harnessing the full interactive potential of digital technologies and networks, by enabling and harmonizing bottom-up (farmers to experts), top-down (experts to farmers), and horizontal (peer to peer) modes of communication, co-production and dissemination of knowledge. Farmers are fully recognized as originators and co-creators of knowledge, which can be fruitfully enhanced through co-development with other actors. Farmers are also considered as co-designers, co-implementers and co-evaluators of technological platforms in the context of agroecology, by including their input and participation at every step of the ICT cycle

3. Vulnerability versus resilience

Conventional: Business models are often based on farmers' dependency on external inputs, including data, energy and ICT devices. Such dependencies may lock farmers within closed solution pathways that fundamentally undermine resilience, while increasing their vulnerability to the effects of possible disruptions.

Agroecology: Designing robust ICT tools and platforms that can adapt to specific environments, as well as resilient solutions that support and encourage farmers' abilities to acquire and share knowledge, carry out autonomous research and strengthen their social networks. Avoiding the creation or intensification of farmers' dependency on prepackaged information, monetized loops and external inputs.

4. Drudgery and hardship versus human and social values

Conventional: Farmers are often regarded as inefficient and unreliable, and farm work as drudgery and hardship. Consequently, replacing their work by algorithms and ICT devices is pitched as desirable. Moreover, farmers and farming

operations are considered as mere sources for data extraction, as well as targets of digital surveillance schemes. Context-based social values are not understood as important elements of agriculture, and therefore not considered in the development of ICTs.
Agroecology: Respecting the integrity of farmers and their communities, as well as their ecosystems, by placing them at the centre, and avoiding socially and ecologically disruptive practices. Promoting farmers' full ownership of tools, methodologies and data, by integrating their views, ideas and values at every step of the ICT cycle. If farmers are compensated properly for their work and investments, they have the means to mechanize and get help for their operations.

5. Startup impact investment versus circular and solidarity economy
Conventional: ICTs are developed typically by following the startup model, and, therefore, tend to contradict circular and solidarity economy principles. ICTs are targets for impact investment with quick and sizable returns.
Agroecology: Embracing the principles of circular and solidarity economy by minimizing the usage of technological resources and waste, and maximizing their potential, as well as emphasizing reciprocal, non-competitive and for-benefit principles.

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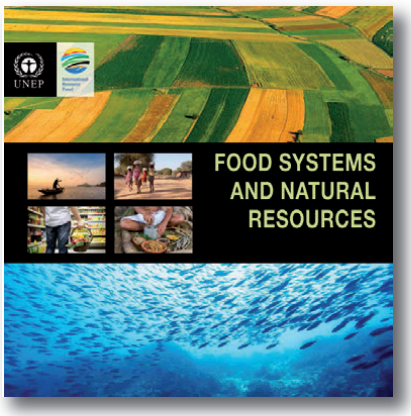
Eugenio Tisselli is a computer scientist, with a transdisciplinary Ph.D. in media art and environmental sciences. He has developed software platforms and sociotechnical methodologies for participatory research and collaborative documentation in rural and urban contexts. His current research focuses on the design and development of the ICT for an agroeocology framework, in collaboration with the Swiss Federal Institute of Technology and Swissaid.

Jacqueline McGlade

Recasting agriculture in a resource-smart food systems landscape

In 2016, the United Nations Environment Programme (UNEP) published the report "Food systems and natural resources".[1] Its main conclusion was that current food systems are exerting increasing pressure on natural resources, and that resource-smart food systems are needed to deliver on the Sustainable Development Goals. The report laid out options on how to decouple the food system from environmental degradation.

UNEP's International Resource Panel Working Group on Food Systems first report came at a time when the 2030 Agenda for Sustainable Development was fresh in the minds of governments and societies around the world (UNEP 2016a). Its main conclusion was that agriculture would benefit from being embedded in the wider context of resource-smart food systems. As Achim Steiner, then Under-Secretary General of the United Nations and UNEP Executive Director said, "A food systems lens goes beyond the classic production-centred discussions to connect all activities concerned with the food we eat … [we] need to transition to more resource-smart food systems, an imperative for the achievement of at least 12 out of the 17 Sustainable Development Goals".



The Panel had been established in 2007 by UNEP to provide independent, coherent and authoritative scientific assessments on the use of natural resources and its environmental impacts over the full life cycle and to contribute to a better understanding of how to decouple economic growth from environmental degradation. Earlier reports linked to agriculture had covered biofuels; sustainable land management; water accounting and decoupling. They all stressed the dependencies of our economies on natural resources that went far beyond any single sector. For agriculture, this meant the use of land, soil water, terrestrial and marine biodiversity, minerals and nutrients and the fossil fuels used in irrigation, energy, packaging, cooking and transport. In addition, food systems were seen to drive a number of environmental impacts such as the loss of biodiversity, soil degradation, water depletion and greenhouse gas emis-

sions. Farmers and food producers were seen as the world's largest group of natural resource managers and as such critical agents of change.

Panel members agreed that the resource use and requirements of the global food consumption called for a better understanding of the food system as a whole, and in particular its role as a node for resources such as water, land, and biotic resources on the one hand and the varied range of social practices that drive the consumption of food on the other. The thinking reflected the findings of the IAASTD report, i.e. that agriculture needed to be treated as part of the larger system of sustainable resource management (UNEP 2016a). The basic idea was that food systems needed to deliver food security and healthy diets for people and to do so sustainably from a resource perspective. The underlying premise was that food systems had to become resource-smart by improving the efficiency of production, as well as by reducing food demand through minimisation of food waste, dietary changes and reduction of resource-intensive foods. Food systems were integral to sustainable development.

Food regimes

The seeds of resource-smart-food came out of a response to the 2008 financial crisis and the rethinking of economic recovery through the Global Green New Deal (UNEP 2009), which saw food security as being radically affected by financial institutions far from the people actually producing food. It took as its point of departure the hegemony of the food regime which dealt with food and the wider politics of food (and agricultural) relations from field to plate through 'the political structuring of world capitalism, and its organization of agricultures to provision labour and/or consumers in such a way as to reduce wage costs and enhance commercial profits' (McMichael, 2013). The environment was never considered in this dialectic.

Food regimes corresponded to time specific political and economic structures, and separated crises in capitalism. The first was the **colonial-diasporic food regime** (1870–1930s) with cheap tropical products such as raw materials (i.e. cotton, timber, rubber) and commodities for direct consumption (i.e. coffee, tea, cocoa), and temperate foods (meat and grains) produced by migrant populations (diaspora) in settler colonies. The second **mercantile-industrial food regime** (1950–1970s) emerged in the wake of the Great Depression of the 1930s and World War II, in the context of government-organized capitalism, cold-war and decolonization. It was typified by a reversal of world agricultural trade flows, via the mechanism of food aid, stemming from government subsidized overproduction in the Global North and by the international expansion of agribusiness value chains through the Green Revolution (i.e. high-yielding varieties of a few cereals such as wheat, maize, rice coupled with the heavy use of subsidized fertilizers, pesticides, irrigation and machinery into the agricultural economies of the Global South). The **corporate food regime** (1980–present) came on the back of the economic and oil crises of the 1970s and the neoliberal turn in global politics. The corporate food

regime extended the global divisions of labour by an intensified conversion of large areas of land in the Global South to produce industrial inputs (e.g. animal feeds and agrofuels) for the Global North and was defined by a market hegemony imposing a set of rules institutionalizing, via the World Trade Organization, corporate power in the food system on transnational, national and local levels, from field to plate. This contributed to a shift in control over global food and agriculture from smallholder based production towards global capital.

Resource-smart food systems aim to address the delinking of global capital flows from agricultural practices and the livelihood strategies of smallholders, that were seen as constraints that needed to be overcome in the name of efficiency, development and food security and which were laid bare in the financial crisis of 2008. It sought to address the deepening of large-scale and industrial forms of agricultural production that were encroaching on nature at odds with ecological processes and the patchy success of the corporate food regime's principles and guidelines for responsible agro-investments, value-chain projects, industry self-regulation and corporate social responsibility. By bringing environmental and resource concerns into the very core of our food systems it could ask questions about outcomes related to wellbeing and the health of people and ecosystems, not just the bottom-line.

Decoupling – the driver behind resource-smart food systems

The members of the Panel saw that the main driver for establishing resource-smart food systems was decoupling (UNEP 2011). This refers to the ability for economies to grow without a corresponding increase in environmental pressures (UNEP 2011). There are two types of decoupling: resource and impact decoupling. Resource decoupling occurs when economic growth exceeds the growth rate of resource use i.e. economic productivity of resources is increasing. Impact decoupling occurs when the environmental impact of economic activities is reduced. Impact decoupling is important when the use of a resource threatens human and ecosystem health. Both are highly relevant to the food system and helped to push UN agencies and governments to rethink agriculture in terms of resource-smart approaches to land and water use, biodiversity and soil conservation, nutrition and health, climate adaptation and the carbon footprint of food production. The shift in thinking was helped by advances in the publication and uptake of environmental accounting frameworks for water and land and the growing use of resource life-cycle analysis (UNEP 2012; 2015). Together these two methodologies helped to quantify the environmental and health impacts arising during the extractive phase of food production (e.g groundwater pollution, land degradation, post-harvest wastes, health effects of pesticide spraying and emissions), and the use phase of food commodities (e.g.transport, packaging, food waste and health impacts of nutrient deficiency).

The idea of resource-smart-food systems was proposed as an umbrella term for more specific policies that were gaining traction at the time such as climate-smart

agriculture. It also covered linkages to new dominant values such as wellbeing and health. It also opened up the space for non-agricultural actors to co-design better health and environmental outcomes. For example, governmental programmes for nutritious school meals stimulating local farmer's options and crop choices.

Some of the critical shifts needed to achieve resource-smart-food systems included a reduction of food loss and waste; reorienting away from resource-intensive products such as meat, empty calories and ultra-processed food; rethinking the whole food environment to help consumers adopt more healthy and sustainable diets; reconnecting rural and urban populations through localised food supply chains; internalizing the environmental externalities into the costs and pricing of food and reinforcing this through legislation to prevent pollution, remove perverse subsidies and pay for environmental services; accounting for the flows of resources between urban and rural areas, and between crops and livestock; reinvigorating investment in rural education and training; research and innovation to decouple food production from resource use and environmental impacts; and building feedback loops between monitoring and reporting of the system effects of food production and the information and actions taken by consumers.

The UNEP report pushed the treatment of food security beyond considerations of famine or food shortage.

Coming out as it did in 2016, the UNEP report not only reflected on the combination of social, economic and environmental issues, that were subsequently brought out in the many synergies amongst the Sustainable Development Goals. Most critically, it helped to shape a deeper understanding of the interlinkages between agriculture, food, nutrition and patterns of consumption and production. For example, the use of nexus or more broadly whole systems thinking, in the UNEP report, pushed the treatment of food security beyond considerations of famine and shortages to issues of food waste, healthy diets and nutritious food, based on healthy soils and the long-term health and ecosystem effects of the pesticides and chemicals used in agriculture. It is from these ideas, that world-wide campaigns led by the United Nations on Food Waste and Healthy People, Healthy Plant, have taken off.

Resource-smart food systems within a circular bioeconomy – from niche to norm

The oldest business model in the world is the circular bioeconomy. Nothing wasted, everything used and reused, with Nature as the powerhouse (Palahí et al. 2020). Agriculture and food production are at the heart of this. The circular bioeconomy seeks instead to draw on nature-based solutions to our everyday needs. With an expanding range of innovative products from agro-forestry and biological processes, resource-smart food solutions can also power other consumer markets that are opening up to biobased solutions such a bioplastics, fuel and packaging from farm organic waste. The circular bioeconomy has the potential to solve the multiple challenges of encouraging local investment, gen-

erating livelihoods and improving health, education and food security whilst protecting ecosystem services such as clean water, biodiversity and cultural heritage.

The world has many millions of rural farmers, many barely making enough to provide food or school fees or medicine. With well-devised policies on land stewardship and well articulated product regulations, many different biobased industries could be established to the benefit of local farmers. Using the principles of agroecology and regenerative agriculture for improving soil health and productivity, all streams of organic waste from crops and vegetation can be processed through integrated composting and into the industrial production of bioplastics and lubricants. Expanding the co-production of these products and resilient crops within the setting of rural communities living in a healthy, biodiverse environment with intact ecosystem services, is another way that farmers can become key player in the circular bioeconomy.

In another step up to addressing some of the most tenacious problems of our fossil-fuel economies, farmers can produce bacteria to take the carbon emitted from agricultural infrastructure, such as grain driers and dairy production facilities and turn it into ethanol of sufficient quality to be used as transportation fuel.

Investing in resource-smart food systems to power the circular bioeconomy

Imagine a setting where virtually everything that is used in everyday life is biobased and reused or recycled. The flows through the economy would add value without creating the large scale negative externalities associated with fossil fuels and chemical pollutants. The circular bioeconomy also fundamentally shifts the risk profile of an investment. Whether it is impact development bonds, green financing or social impact bonds, the evidence is that investments in nature-based solutions and the bioeconomy are top-tier. The European Bank for Reconstruction and Development, with partner countries in northern Africa, has earmarked portfolios of green projects and social projects against which the proceeds of its Green Bonds and Social Bonds are tracked. These bonds are issued in accordance with the Green Bond and Social Bond Principles and are linked to projects such as sustainable and stress-resilient agriculture, including investments in water-efficient irrigation and sustainable forest management, reforestation, watershed management, and the prevention of deforestation and soil erosion.

In the circular bioeconomy, farmers are not only part of the resource-smart food system, they are land stewards with the potential to transform our economies (Palahí et al. 2020). As the potency of these ideas gain traction, it is useful to recall that they are a legacy of the IAASTD findings and the UNEP 2016 report which showed the world how to think about agriculture in the wider context of environment and natural resources.

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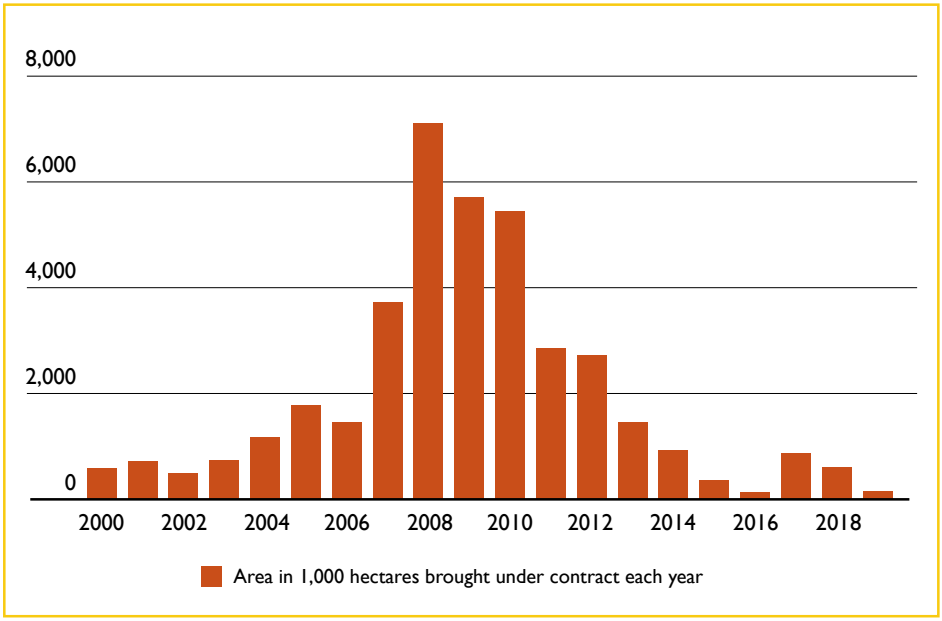
20-Year Comparison

Transnational land deals



Transnational land deals greater than 200 hectares with a concluded contract according to area size under contract in the respective year based on Land Matrix data as of April 2020.

The global land rush – a big deal

Soaring food prices in 2007-08 and again in 2010, coupled with the instability of global financial markets, turned farmland into a new strategic asset, causing a land rush by international investors. These land acquisitions mainly targeted accessible, fertile cropland that had often previously been used by smallholders and communities. In 2009, the Land Matrix, an independent land-monitoring initiative, started to collect information on land deals for which public information is available. By July 2020, the database held information on concluded, intended and failed deals covering almost 82.5 million hectares. The infographic above shows 1,436 concluded deals for the years 2000 to 2019, covering 39.26 million hectares. A further 368 undated deals brings the total area of concluded deals to 51.29 million hectares. Although the infographic includes most types of investment, the majority of deals are for farming purposes. The peak of the land rush was 2008, both with respect to the size (7.1m ha) and to the number of deals (193 acquisitions), and from 2011 onwards, a clear downward trend is visible. Eastern Europe has been the main target region in terms of the total area of concluded deals, followed by Africa which has the largest number of concluded deals. The top target countries are Russia (12.3m ha), Indonesia (3.8m ha), Papua New Guinea (3.7m ha), Brazil (3.7m ha) and Ukraine (3.3m ha), followed by South Sudan and Mozambique with 2 milllion hectares respectively.

Sources

1 Data compilation from Land Matrix by Ward Anseeuw in April 2020. Data was extracted using default filters, which include all intentions of investment except oil/gas extraction, pure contract farming, mining and forest concessions and exclude deals made exclusively by domestic investors. https://landmatrix.org/data

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Ward Anseeuw

Access to land and the emergence of international farm enterprises

The 2009 IAASTD report highlights the need to target "small and medium-sized family farms as priority beneficiaries for publicly funded agricultural research and extension, marketing, credit and input supplies; undertaking land reform, where needed; investing in human capital to raise labor productivity and increase opportunities for employment; ensuring that agricultural extension, education, credit and small business assistance programs reach rural women; setting public investment priorities through participweassatory processes; and actively encouraging the rural non-farm economy".

During that very same period as the IAASTD Report was published, following the food price crisis of 2008-2009, a new 'global land rush' developed. It entailed large-scale land acquisitions mainly by private investors (but also by public investors and agribusiness) buying farmland or leasing it on a long-term basis to produce agricultural commodities, i.e. raw materials for global industrial value chains. These investors responded to the prospects of a growing demand for food, animal feed, fuels and fibre, combined with the liberalisation of trade and investment regimes and increased price volatility – all factors that fuelled the new global rush for land (Anseeuw et al. 2012). It was also a response to invitations by numerous host governments, mainly in Africa and Asia, which instead of promoting endogenous growth of small and medium-sized family farms as promoted by the IAASTD, were exploiting this hype as an opportunity to attract private, mainly international capital. In view of reduced public spending and Official Development Assistance (ODA), these investments were presented as solutions contributing to the countries' agricultural revitalisation - directly through large-scale investment or through a positive pull-effect integrating the host countries' small-scale farming sector (Cotula et al. 2009). Such investments, focussing on the development of large-scale agricultural estates, would enhance their national food security situation and develop rural infrastructure. So went the narrative.

A new global land rush was fuelled by a growing demand for food, animal feed, fuels and fibre.

This rush for land primarily affected agrarian economies, mainly in Africa and Asia. Lands that in the early 2000s seemed marginal to investment interest were being sought by international investors and speculators in quantities hitherto unseen. Between 2000 and 2016, with a peak in 2010, foreign investors acquired 42.2 million hectares of land around the globe. 26.7 million hectares were for farming purposes, according to a Land Matrix report that covers a thousand

concluded agricultural deals (Nolte et al. 2016). Africa accounts for 42% of these deals, and about 10 million hectares of land. This being said, few are the deals that are producing effectively: Presently, about 10 years after the hype of acquisitions, only 27% of the area is showing effective production-related activities (from land preparation to crop production), although effective production is increasing on the still active deals (Land Matrix 2019). Managerial and technical difficulties related to the implementation of large land deals in often isolated, difficult ecological, political, bureaucratic and socio-economic environments explain this low implementation, as well as high failures. In Madagascar for example, out of the 53 deals identified since 2000, only four are still active today. Not only do these failed deals not contribute to the promised expectations with regards food security and development; in most of the cases, land rights – which have changed in the process – are not returned to local (sometimes displaced) populations. Even though the global land rush has now ebbed, new acquisitions are still being recorded, contributing to growing commercial pressures on land.

Foreign land acquisitions increase commercial pressure on land and weaken land rights of the local population.

In addition, in general, these processes tended to fuel unrealistic expectations on the part of the host countries and local populations: contribution to food security, creation of jobs, as well as development of productive and non-productive infrastructure such as schools, hospitals, besides others, are generally lower than expected. Very few, if any cases have led to an effective agrarian transformation, particularly since a common characteristic of such offshore production models and farm enterprises is the lack of local integration, sometimes even referred to as enclave economies (White et al. 2012). Contrary to the call of the IAASTD to implement at the national and international level, using governance mechanisms to respond to unfair competition and agribusiness accountability, these acquisitions reflect an increasing control by international farm enterprises over land-based productive cycles – primary agricultural production in particular – representing far-reaching trends of vertical integration.

The slowdown and lack of implementation of large-scale land acquisitions should not lead to complacency, as they still exacerbate commercial pressure on land and lead to a weakening of land rights for the local population. Indeed, these international investors, as well as the public, semi-public or private sellers, often operate in legal grey areas between traditional land rights and modern forms of property (Nolte et al 2016). The IAASTD covers the problem of unfair distribution of land, which has existed for many centuries, as well as approaches to agrarian reforms and communal land use. Its key message is simple: Secure land tenure, property rights and other forms of common ownership, including access to water, are an essential prerequisite for family farms to invest in their own future. The present large-scale land acquisition policy approach, however, reflects more a top-down land reform, implemented in non-transparent ways, without accountability measures. It not only leads in many cases to land expro-

priation and displacements, it also affects land rights of the rightful owners and occupiers of the land, while exacerbating land concentration and inequalities.

Overall, instead of the options of action promoted by the IAASTD, the outsourcing of the development of the agricultural sector by host governments in the South to international farm enterprises simply represented a quick fix. The results were marginal and led to mostly negative impacts for food security and development at large, rather than a process of genuine structural agrarian transformation based on endogenous small and medium-sized farm development. However, more recently, international interest in land has triggered domestic interest as well: and the question remains, do these domestic investments reflect opportunities for local agricultural development or do they present a new wave of domestic land grabs by urban elite (Jayne et al. 2019)?

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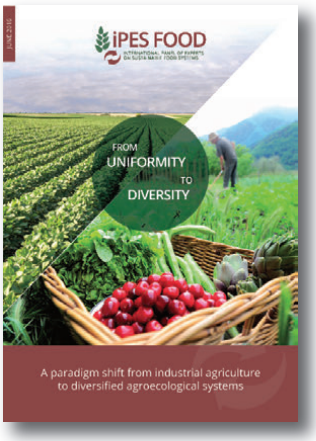
Emile A. Frison

From uniformity to diversity

In 2016, IPES-Food published the report "From Uniformity to Diversity",[1] promoting a paradigm shift from industrial agriculture towards diversified agroecological systems. It identifies the key mechanisms that keep today's industrial food system in place, and recommends 7 pathways that would enable a transition towards diversified agroecological systems.

When I was appointed Director General of the International Plant Genetic Resources Institute in 2003, I recognized that it was the right moment to move beyond an exclusive focus on plant genetic resources; the time had come to fully embrace the complexity of agrobiodiversity that constitutes the reality of farmers' daily lives across the world. Understanding how agrobiodiversity contributes to better nutrition, resilience, stability and sustainability became a significant part of the research agenda at the Institute. This shift led to the Institute's name change to 'Bioversity International', reflecting the broadening of the agenda.



At the launch of the IAASTD process, because of the multi-stakeholder nature of the process, I volunteered to represent the CGIAR (Consultative Group on International Agricultural Research) Centres in the Bureau. Despite the participation of a number of CGIAR scientists as authors in the Assessment, there was little interest from the CGIAR leadership in the process. The food price spikes in 2007-2008 further distanced the majority of CGIAR Commodity Centres from the IAASTD process and saw a redoubled focus on breeding for productivity increases of the major cereals. When in 2008, the CGIAR Centres had to decide whether they would sign off on the IAASTD report, the majority of Centres voted against, on the basis that it was critical of genetic modifications and of unrestrained trade in agricultural commodities. As the then Chair of the Alliance of CGIAR Centres, I was obliged to convey the objections of the Centres and their withdrawal from the process, despite the fact that I was personally very supportive of the report.

I supported the recommendations of the report because of its pioneering recognition of the fact that agriculture and agricultural research needed a significant redirection, away from the high input monocultures of a narrow genetic base of a few commodities, towards greater diversity and the application of agroecology principles. The report was an inspiration for me and convinced me

of the need to take a broader systems approach and to deepen our work on the role of agrobiodiversity in improving the lives of smallholder farmers.

When in 2013, I stepped down from my position of Director General of Bioversity International, I decided to focus my efforts on sustainable food systems (SFS) and on agroecology as a significant component of SFS. With the support of the Daniel and Nina Carasso Foundation, I helped to set up an independent "International Panel of Experts on Sustainable Food Systems" (IPES-Food) whose focus was to bring the issue of sustainable food systems to the attention of decision makers. I was invited to join the Panel in 2015 and I took on the task of Lead Author of the first substantive report of IPES-Food entitled: "From Uniformity to Diversity, a paradigm shift from industrial agriculture to diversified agroecological systems" published in June 2016.

This was the first report that made a systematic comparison between the industrial model of agriculture (the dominant paradigm) and the emerging diversified agroecological system from an economic, environmental, nutritional, health, social and cultural point of view. The report pointed to the fact that the focus on productivity increases of industrial agriculture was at the expense of numerous unsustainable negative environmental, health and social consequences. Consequences that were being considered as 'unavoidable' negative externalities, paid for by society at large, and presented as necessary to 'feed the world'.

The report went on to highlight the potential that diversified agroecological systems offer in terms of their economic, environmental, nutritional, health, social and cultural performance, detailing the many positive externalities that are currently not being rewarded by the market.

The IPES-Food report is unique in the depth of its analysis of the political economy and the identification of eight 'lock-ins' that prevent, or are significant obstacles to, the necessary paradigm shift to diversified agroecological systems. These 'lock-ins' are described below.

Lock-in 1: **Path dependency**
Industrial agriculture requires significant up-front investments in terms of equipment, training, networks and retail relationships, and often requires farmers to scale up. Once these investments and structural shifts have been made it becomes increasingly difficult for farmers to change course.

Lock-in 2: **Export orientation**
As industrial agriculture has spread, generating abundant supplies of uniform, tradable crop commodities, trade has taken on disproportionate political importance. Specific supply chains (e.g. supply chains for animal feed or for processed food ingredients) have become increasingly export-oriented and export-dependent. Supporting these chains has often been prioritized over

other interests such as ensuring resources for local food production. In addition, in spite of the risks and problems associated with export orientation and regional monocultures, including price volatility, environmental degradation and competition for land, various policy measures have continued to incentivize export orientation.

Lock-in 3: **The expectation of cheap food**
Industrial agriculture and shifting consumer habits have helped to facilitate the emergence of mass food retailing, characterized by the abundance of relatively cheap highly-processed foods, and the year-round availability of a wide variety of foods. In many countries, consumers have become accustomed to spending less on food. In this context, farmers have received clear signals to industrialize their production in order to respond to the increasing demand for large volumes of undifferentiated commodities.

Lock-in 4: **Compartmentalized thinking**
Highly compartmentalized structures continue to govern the setting of priorities in politics, education, research and business, allowing the solutions offered by industrial agriculture to remain at centre stage. Agricultural ministries, committees and lobbies retain a privileged position relative to other constituencies such as environment and health in setting priorities and allocating budgets for food systems. Increasingly privatized agricultural research and development programmes remain focused on the handful of commodities for which there is a large enough market to secure significant returns. Educational silos remain in place, and sectoral 'value chain' organizations share knowledge vertically (by product) rather than encouraging a wider, food systems approaches.

Lock-in 5: **Short-term thinking**
Diversified agroecological systems offer major benefits for farmers and for society. However these advantages will not be immediately visible, given the time needed to rebuild soil health and fertility, to increase biodiversity in production systems, and to reap the benefits of enhanced resilience. Unfortunately, key players in food systems are often required to deliver short-term results. Politicians are often locked into short-term electoral cycles that encourage and reward policies that deliver immediate returns and publicly-traded agribusiness firms are generally required to deliver rapid returns to shareholders.

Lock-in 6: **'Feed the world' narratives**
Despite the fact that food security is recognized primarily as a distributional question tied to poverty and access to food, achieving food security continues to be framed by many prominent actors as a question of how to 'feed the world', or in other words, how to produce sufficient calories at the global level. These narratives and approaches have been particularly prominent in the wake of the 2007-2008 food price spikes.

Lock-in 7: **Measures of success**
The criteria against which farming is typically measured - e.g. yields of specific crops, productivity per worker – tend to favour large-scale industrial monocultures. Evidence in recent long-duration studies suggests that diversified agroecological systems can compete well on productivity grounds. However, they are still disadvantaged by the predominant measures of success. Diversified systems are by definition geared towards producing diverse outputs, while delivering a range of environmental and social benefits on and off the farm. Narrowly-defined indicators of agricultural performance fail to capture many of these benefits. Current systems will be held in place in so far as they continue to be measured in terms of what industrial agriculture is designed to deliver, at the expense of the many other outcomes that really matter to, and directly impact society.

Lock-in 8: **Concentration of power**
The way food systems are currently structured allows value to accrue mainly to a limited number of actors. This reinforces their economic and political dominance, and thus their ability to influence the governance of those systems. The interests of these powerful actors converge to support industrial agriculture.

Finally, the IPES-Food report identifies a set of coherent steps designed to strengthen the emerging opportunities while simultaneously breaking the vicious cycles that keep industrial agriculture in place. Together, these steps will shift the centre of gravity in food systems, allowing harmful dependencies to be cut, agents of change to be empowered, and alliances to be forged to sustain change.

Recommendation 1: Develop new indicators for sustainable food systems.
It is essential to adopt a broader range of 'measures of success', covering long-term ecosystem health; total resource flows; sustainable interactions between agriculture and the wider economy; the sustainability of outputs; nutrition and health outcomes; livelihood resilience; and the economic viability of farms with respect to debt and climate shocks.

Recommendation 2: Shift public support towards diversified agroecological production systems.
Governments must shift public support away from industrial production systems, while rewarding the positive outcomes of diversified agroecological systems. Governments should implement measures that allow farms to diversify and transition towards agroecology. In particular, policy makers must focus on supporting young people to enter agriculture and adopt agroecological farming – before they are locked into the cycles of industrial agriculture.

Recommendation 3: Support short supply chains & alternative retail infrastructures.
Governments should support and promote short circuits in the supply chain in order to make them a viable, accessible and affordable alternative to mass retail

outlets, e.g. by repurposing infrastructure in cities to favour farmers' markets. More attention should also be paid to the role of informal markets, and policy measures ought to be put in place that empower emerging initiatives linking farmers to consumers.

Recommendation 4: Use public procurement to support local agroecological produce.
Public procurement should be used with increasing ambition to provide sales outlets for diversified agroecological farms, supplying fresh, nutritious food and diversified diets for the users of public canteens, particularly schoolchildren.

Recommendation 5: Strengthen movements that unify diverse constituencies around agroecology.
Governments can support farmers' groups, community-based organizations and social movements which encourage the spread of agroecological practices and advocate sustainable food systems. In addition, governments must encourage the participation of diverse civil society groups from the global North and South in governance processes and forums.

Recommendation 6: Mainstream agroecology and holistic food systems approaches into education and research agendas.
Public research agendas must be redefined around different priorities. Investments should be redirected towards equipping farmers to shift their production. The mission of university research should be redefined around the delivery of public goods. The United Nation's Food and Agricultural Organization (FAO) and other international agencies should mainstream agroecology into all of their work, spreading existing knowledge and filling the remaining gaps in our understanding. In addition, research conducted by the CGIAR Centres should be refocused around diversified agroecological systems and farmer participatory research.

Recommendation 7: Develop food planning processes and 'joined-up food policies' at multiple levels.
It is crucial to implement joined-up policymaking for food systems. Long-term, inter-ministerial planning – reaching across political boundaries and transcending electoral cycles – should be supported. This is necessary to build on landscape management and territorial planning initiatives, where food security can be meaningfully targeted and understood in terms other than 'feeding the world'. Crucially, food systems planning must be based on broad participation of various constituencies and groups with a stake in food systems reform. At the global level, the Committee on World Food Security (CFS) should advocate for coherent food policies and contribute to strengthening diversified agroecological food systems.

One lock-in that was not sufficiently addressed in the recommendations of the 2016 IPES-Food report was the concentration of power. This issue was tackled in a subsequent report by IPES-Food entitled: "Too Big to Feed" published in 2017.

The publication of the IPES-Food report "From Uniformity to Diversity" has been widely adopted by different stakeholders. Since its publication, I have been invited on multiple occasions to present the report at meetings, conferences and events organized by universities, farmers' organizations, civil society organizations and ministries. The report, which is now widely cited, has also contributed to raising the profile of agroecology in a variety of different institutions and inspired the strategies of several civil society organizations working on food security and sustainable development.

Recently, there has been a significant increase in interest in agroecology to address today's challenges. in the last two years alone multiple reports have been published that point to the need for transformational change in our agriculture and food systems, with a focus on the urgency to bring about such change These include the IPBES report on Land Degradation and Restoration (2018), the TEEB for Agriculture & Food report (2018), the IPBES Global Assessment Report on Biodiversity and Ecosystem Services (2019), the IPCC report on Climate Change and Land Use (2019), the HLPE report on Agroecological and Other Innovative Approaches for Sustainable Agriculture and Food Systems (2019), the Global Climate Adaptation report (2019) and the Global Sustainable Development Report 2019. All these reports recognize diversification and agroecology as key to transformational change.

This is encouraging, but major efforts from policy makers and private enterprise are still needed to overcome the lock-ins listed above. Overcoming these will be key to ensuring that agroecology becomes the new, mainstream, dominant model.

Endnote

1 http://www.ipes-food.org/_img/upload/files/UniformityToDiversity_FULL.pdf

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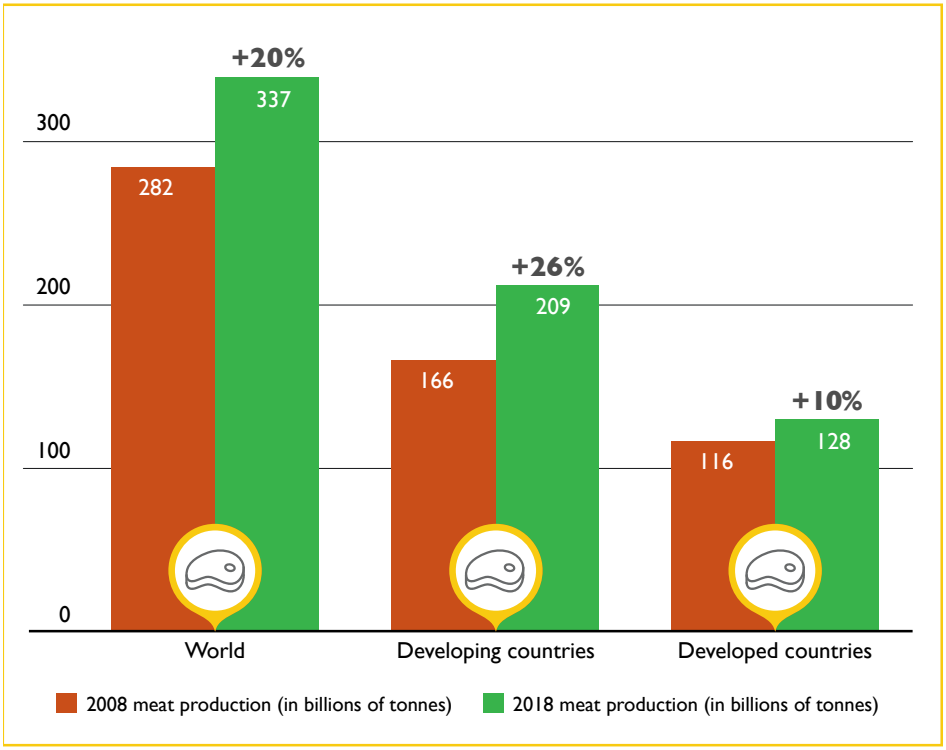
10-Year Comparison

Meat production



Meat production worldwide, in developing and developed countries in million tonnes carcass weight equivalent for the years 2008 and 2018 – and the corresponding increase in per cent

Just how much meat can we eat?

Worldwide, 337 million tonnes of meat were produced in 2018. Global meat production increased by 20% compared to ten years earlier, with growth more pronounced in developing countries, which experienced an overall increase of 26% during the period. In 2018, developing countries' share in global meat production was 62%, up from 59% in 2008. It should however be noted that large amounts of meat are traded internationally, and that figures for meat production in one region do not necessarily correspond with meat supply or consumption in that same region. OECD and FAO predict that production will reach almost 364 million tonnes by 2028, with developing countries accounting for 74% of the additional output.

Sources

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Robert G. Wallace

Agriculture, capital, and infectious diseases

SARS-CoV-2, the coronavirus that has swept the world, represents only one of a series of novel pathogen strains that have suddenly emerged or re-emerged as human threats this century. These outbreaks – avian and swine influenza, Ebola Makona, Q fever, Zika, among many others – are more than matters of bad luck. Nearly all can be tied distally or directly to changes in production or land use associated with intensive agriculture, even as other modes of production have been implicated, logging and mining among them (Jones et al. 2013).

Monoculture production – crop and livestock alike – drives the deforestation and development that increases the rate and taxonomic scope of pathogen spillover from wildlife to food animals and the labor that tends them. Once these pathogens enter the food chain, such production can select for increases in pathogen deadliness, genetic recombination, and antigenic shifts out from underneath immune suppression. By the expansive trade that now characterizes such production, the newly evolved strains can be exported from one side of the world to the other.

SARS-CoV-2 and the other novel pathogens are not just matters of an infectious agent or clinical course. They cannot be fixed merely by the latest in vaccines and other prophylaxes, as important as these biomedical interventions may be. Farther out, the webs of ecosystemic relations that industry and state power have pinned back to their own advantage have had a foundational effect on the emergence and evolution of these new strains (RG Wallace et al. 2015). The wide variety of pathogens, representing different taxa, source hosts, modes of transmission, clinical courses, and epidemiological outcomes, mark different parts and pathways of something of the same regimens in land use and value accumulation spread across the world.

Monoculture production drives the deforestation and development that increases the rate of pathogen spillover from wildlife.

We find this new context reproduced region by region. Despite differing in their particularities, local circuits of production operate within the same web of global expropriation and its environmental impacts. At one end of the production circuit, the complexity of primary forest typically bottles up "wild" pathogens. Logging, mining, and intensive plantation agriculture drastically streamline that natural complexity (R Wallace et al. 2018). While many pathogens on such "neoliberal frontiers" die off with their host species as a result, a subset of infections that once burned

out relatively quickly in the forest, if only by the irregular rate of encountering their typical host species, are now propagating much more widely across susceptible populations.

The vulnerability to infection that human populations suffer on the receiving end of the spillovers is routinely exacerbated by austerity programs impacting both environmental sanitation and public health. Even in the face of efficacious vaccines, the outbreaks that emerge out of their environmental margins are increasingly characterized by greater geographic extent, duration, and momentum. What were once local spillovers are now suddenly epidemics, some finding their way onto global networks of travel and trade.

Ebola offers a now archetypical example (RG Wallace and R Wallace 2016). Ebola Makona, the Zaire ebolavirus variant underlying the regional outbreak in West Africa 2013-2015, appeared conventional in its initial genetics, case fatality ratio, incubation period, and serial interval. Unlike previous outbreaks that wiped out a village or two, however, Makona infected 35,000 people, killing 11,000, leaving bodies in the streets of major capital cities.

How to account for the difference if not by the Ebola virus itself? It is instead the socioecological background through which the pathogen spread – from local environmental and social spaces out to global relational geographies – that shifted. Multilateral structural adjustment and a multinational land rush encroached upon regional forests and truncated medical infrastructure. New incursions of monoculture plantation – palm oil, sugar cane, cotton, and macadamia among other crops – were tied to new rounds in land enclosure, consolidation, and commodization of previous subsistence trading. These shifts increased the interface between Ebola-bearing species of bats attracted to such plantations and the now partially proletarianized laborers who cultivated them. The resulting increases in Ebola spillover likely accelerated the emergence of a human-to-human infection (Rulli et al. 2017, Olivero et al. 2017).

Of the 39 documented transitions from low to high pathogenicity in avian influenzas, all but 2 occurred in commercial poultry operations.

Diseases of other taxa tag the other end of the circuit of production. Highly pathogenic and suddenly human-adapted avian and swine influenzas typically first emerge as newly identifiable infections in intensive operations located closer to major cities in both fully industrialized countries and those in the middle of undergoing economic transitions to more industrialized regimes. Of the thirty-nine documented transitions from low to high pathogenicity in avian influenzas from 1959 on, Dhingra et al (2018) identified all but two occurred in commercial poultry operations, typically of tens or hundreds of thousands of birds.

On the other hand, reassortment events, wherein different H5 and H7 influenza strains traded genomic segments, occurred largely in countries undergoing eco-

nomic transitions. These latter environments appear to be characterized by a greater mix of production systems, permitting different combinations of co-circulating strains. Indeed, such intensive poultry operations are so inundated with circulating strains that they serve as their own reservoir for new subtypes (Olson et al. 2014). Wild waterfowl are no longer the only source.

Other pathogens emerge in more complex origins across these circuits. SARS-1 and now SARS-2, our COVID-19 strain, appear to have emerged out of mixed niches spread across their associated regional circuits of production. Non-human SARS specimens have been isolated in greater Hubei, Wuhan's province, as far back as 2004, in both bats – Shortridge's horseshoe bat and the greater horseshoe bat – and farmed masked palm civets (Hu et al. 2005, Tang et al. 2006). The isolates appear part and parcel of a wide range of animal SARS distributed across China, including in adjacent provinces Anhui and Jiangxi, well within Wuhan's wild foods catchment, but also as far south as Guangdong, another source from which SARS-2 may first have arisen (Forster et al. 2020).

Given the genetics of SARS-2 – a recombinant of bat and pangolin strains – the increasingly formalized wild food trade in all likelihood played a foundational role in the emergence of the COVID-19 outbreak (Challender et al 2019, Xiao et al. 2020, Li et al. 2020). The trade, including now pangolin farming, shares with industrial agriculture sources of capital and economic geographies encroaching on Central China's hinterlands. Whether the outbreak began at the infamous Wuhan live food market itself or at the other periurban terminus is beside the point. Instead, we need readjust our conceptual sights on the processes by which living organisms are turned into commodities and entire production chains – animal, producer, processor, and retailer – entrained as disease vectors.

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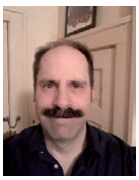
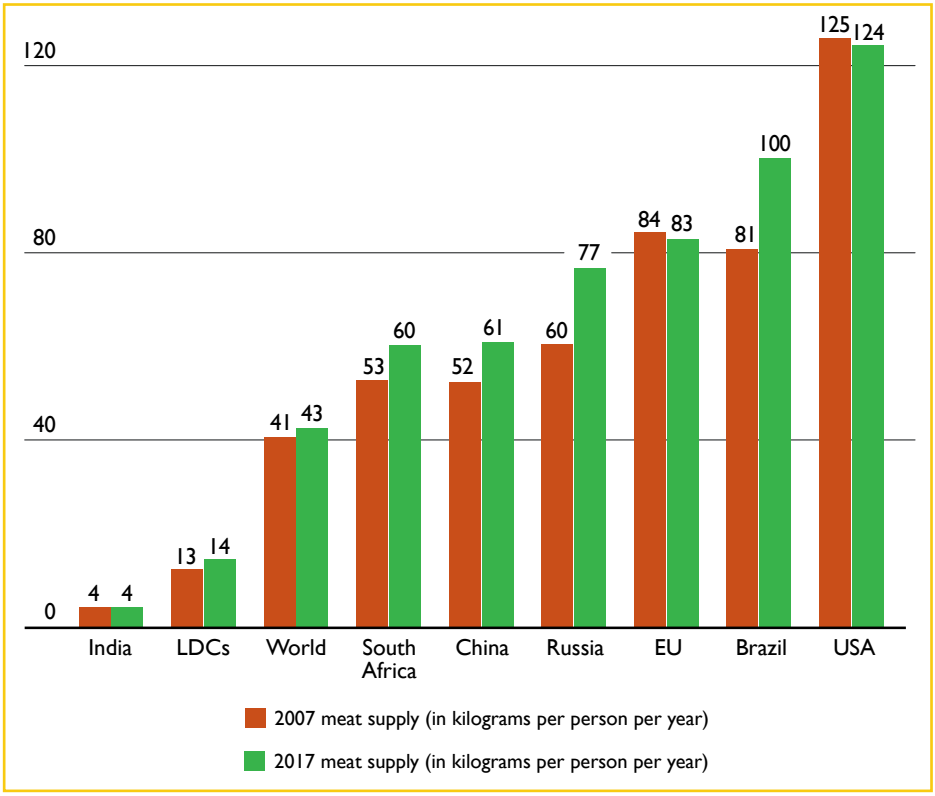


Robert G. Wallace is an evolutionary epidemiologist with the Agroecology and Rural Economics Research Corps. He is co-author of Neoliberal Ebola: Modeling Disease Emergence from Finance to Forest and Farm (Springer, 2016), and Clear-Cutting Disease Control: Capital-Led Deforestation, Public Health Austerity, and Vector-Borne Infection (Springer, 2018). He has consulted for the Food and Agriculture Organization of the United Nations and the Centers for Disease Control and Prevention (CDC).

Meat supply



Meat supply in kilogram per person per year in the BRICS countries, the EU, the world's least developed countries (LDCs) and the global average. Data for 2007 and 2017 from FAO Food Balances (2017 figures were calculated on a slightly amended methodology and with revised population figures).

The changing appetite for meat

In 2017, a total of 42.6 kilograms of meat per person was available for human consumption worldwide, an increase of 4.6% compared to ten years earlier. This was possible because production grew faster than the world population. The global average conceals large differences between countries. In 2017 meat supply stood at 14 kilograms per person in the world's poorest countries, roughly 83 kilograms per person in the EU and a staggering 124 kilograms per person in the US. Meat supply refers to the amount of meat available at the retail level after taking into account imports and exports and changes in stocks. The amount of meat actually consumed may be lower due to food loss and waste. In most BRICS countries, a combination of income and population growth and rising urbanisation translated into increased demand. However, meat consumption is not only influenced by economic factors but also by cultural and religious aspects. In India, where a large proportion of the population is vegetarian, meat supply has remained almost unchanged at four kilogram per person over the past decades. In the EU, meat supply has recently started to stagnate, and is showing signs of a slight decrease.

Sources

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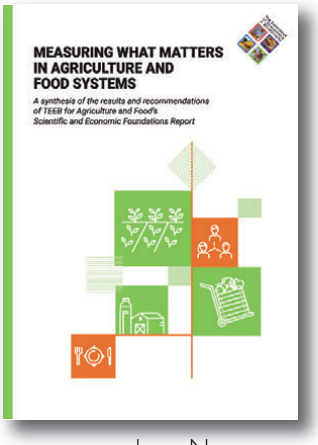
Alexander Müller & Nadine Azzu

"It's the economy, stupid!"

TEEBAgriFood, a new framework to measure and value the success and failure of food systems

In 2018, The Economics of Ecosystems and Biodiversity (TEEB) published a report entitled "Measuring what matters in agriculture and food systems"[1] that developed a comprehensive framework for analysing food systems. The report references the value of the contribution of the natural resource base to agricultural production, the positive or negative impacts of production on nature, its interaction with society, and its impact on human health. In doing so this *report* provides an overview of the true cost of food.

A quick internet search for the quote "our food system is broken" provides over 46,000 results within 0.35 seconds. Clearly, a new narrative is emerging that tries to explain the problems of the world's food system. This narrative, "the food system is broken", is increasingly heard at many conferences from speakers with different professional backgrounds, and has become a catch phrase. It is surprising to see that people who have worked for many years on improving the efficiency of food production can now agree on this narrative.



"Fixing a broken food system" without considering the underlying reasons for its failure will fall short of finding a solution. We think that the "broken food system" narrative is hiding a much bigger problem. The economy driving the whole system is broken! This is the core of the problem. And what is at the core of the problem should also be at the core of our attention. Otherwise, a wrong narrative diverts attention away from the necessity to develop a new solution.[2]

The list of unsolved problems in the global food system is long. No one can contest the fact that over 800 million people are hungry and two billion are malnourished – yet obesity is growing and not only in developed countries. No one can contest the negative impact of farming on natural resources or its contribution to climate change. The scientific evidence is over-

whelming. The same is valid in relation to the fact that small scale farmers and workers in the food chain are often underpaid and many are poor; conglomeration of food businesses continue at a global scale, industrial production of seeds and fertilizers is moving towards oligopolies, and major global food brands can be found all over the world; six out of ten global health risks for humans are caused by food; and one third of all food, annually, is wasted.

These considerations beg the following questions: (i) how can we tell if the food system is not working, and is broken – i.e. what are the characteristics or indicators of a functioning food system?; and (ii) based on these characteristics, what metrics should be used to measure the performance of the food system?

To date, the "success" of a food system is measured with simple economic metrics: productivity and yields per hectare.

To date, the "success" of a food system is predominantly measured with simple economic metrics: productivity (output per unit of input), and yields per hectare. In recent decades the increases in yields are impressive both in terms of per hectare productivity (in some parts of the world), and in the amount of food produced globally. According to FAO the world is currently producing enough calories for there to be enough for everybody. No one should go to bed hungry. So why are there so many hungry people? Measured against these two predominant success indicators positive results are shown. According to these indicators we are producing enough food, so everyone should be fed. But this is not the case. Therefore, currently productivity is not the problem, but rather access to food. People are hungry because they are poor.

Let us approach the question "is the food system broken?" from a different, environmental perspective. The impact of agricultural production has been analysed in several studies[3] and the results are – again – pretty clear: the agriculture sector is to a large extent responsible for the degradation of natural resources and is one of the main emitters of greenhouse gases. As a nature-based industry, agriculture is therefore undermining its own foundation. From this perspective, there is a contradiction. Additionally, the agriculture sector is responsible for a massive loss of biodiversity (e.g. insects for pollination) while at the same time it is dependent on genetic resources.

Therefore, the question is, are we measuring the success or failure of the food system against the right indicators, or do we need new metrics for measuring and valuing the performance of food systems accurately. We are proposing to reflect all capital (produced, natural, human and social) and associated costs (externalities, both positive and negative) in the valuation of food systems.

The Economics of Ecosystems and Biodiversity for Agriculture and Food (TEEBAgriFood) was designed to illustrate how best to capture the complex reality of "eco-agri-food" systems in a holistic manner. The aim was to move beyond

the risks and limitations inherent in simplistic metrics such as "per hectare productivity" and to develop a metric that covers the whole system and not only parts of it.

The term "eco-agri-food systems" is used to describe the interconnectedness and complexity of all dimensions of sustainability involved in food production, processing, distribution and consumption including human health. It highlights the "eco" (i.e. natural ecosystem) source of important but economically invisible inputs to agricultural production, in particular those provided by ecosystem services. It measures and values the positive or negative impacts of production on the environment which in the standard accounting system remain economically invisible. A key aspect of using this term is the emphasis on thinking in terms of value chains (systems thinking), as opposed to thinking in production silos.[4] System thinking unveils drivers of change as determined and impacted by feedback loops, delays and non-linear relationships, in the context of change along the value chain.

Ignoring natural, social and human capital keeps people hungry and drives degradation.

The TEEBAgriFood report[5] developed a comprehensive framework for analysing food systems. In particular, it values the contribution of the natural resource base to agricultural production, as well as the positive or negative impacts of production on nature. It also analyses the value of interaction with society (e.g. employment), the impact on human health (health benefits and costs), and ultimately provides an overview of the true cost of food. In summary, it captures all elements of the food system and how they interact.

More broadly, TEEBAgriFood is part of an ambitious undertaking, aiming at changing the most powerful figure of the world, the Gross Domestic Product (GDP)[6]. The way all economies of the world measure the value of products and services, and how they measure the growth and success of all their economic activities is concentrated in one figure: GDP has become the universal indicator of development. It drives economic and political thinking, and is even one of the key indicators for developing countries in achieving the Sustainable Development Goals. And yet, as an indicator of success, the GDP is riddled with shortcomings: it values short-term growth and ignores medium-term impacts of pollution and degradation of natural resources, and it does not take into account social implications created by growth.

In Minnesota, a study of key externalities of two corn production systems – genetically modified (GM) and organic – was conducted by using the true cost accounting method by following TEEBAgriFood evaluation framework, in terms of stocks and flows of the four capitals (produced, natural, human and social). The study focused on the production side of corn systems only, because of challenges associated with the gathering and assembling of a large amount of data into the framework template. Hence, the assessment was carried out by

a multi-disciplinary team because the analysis focused on quantitative data, but also descriptive information, monetary and non-monetary information. The study revealed higher hidden social, environmental and health related costs associated with GM corn production systems. While there was a positive influence of both systems on produced and social capital, for GM corn production systems, the increasing divide between large and small-scale farmers lead to negative social, health and environmental impacts. For organic production systems, there are positive economic, social, health impacts, with limited environmental impacts. Data limitation for comparison of the two systems showed that the TEEBAgriFood framework was particularly useful in assessing macro level data required for policy analysis; it lent itself to reviewing wider impacts of the entire corn value chain in order to modify policies and practices.[7]

From our perspective, the most important contribution of TEEBAgriFood is that it has changed the way we think about the economy of food systems: TEEBAgriFood demonstrates that the economics of the food system are the problem! Measuring only produced goods and services (produced capital) has created the problem, ignoring natural, social and human capital. This – together with poor governance and inappropriate policies – keeps people hungry and drives degradation. And that is far worse.

To conclude: What is at the core of the problem must now be at the centre of our attention – the findings of TEEBAgriFood call for research, politics and all ongoing multi-stakeholder processes to reassess our hitherto central economic beliefs. Nothing less is required to create a new economic foundation for sustainability. Without this reassessment, more systems will be broken.

Endnotes

1 http://teebweb.org/agrifood/wp-content/uploads/2018/10/Layout_synthesis_sept.pdf

2 Here we focus solely on the economics of the food system. Questions of access to food, poverty and stability of supply including trade are outside the remit of this essay and will need to be considered additionally. We are however convinced that a new economy for sustainability needs to be in the centre.

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5 http://teebweb.org/agrifood/reports/ The TEEBAgriFood report was written and reviewed by 150 people from more than 30 countries analyzing all aspects of today's food systems. Its system approach goes beyond the concept "from farm to fork" because it starts with the natural resource base and also takes into account both human and planetary health.
6 https://www.project-syndicate.org/commentary/why-gdp-by-philipp-lepenies-2016-08?barrier=accesspaylog.
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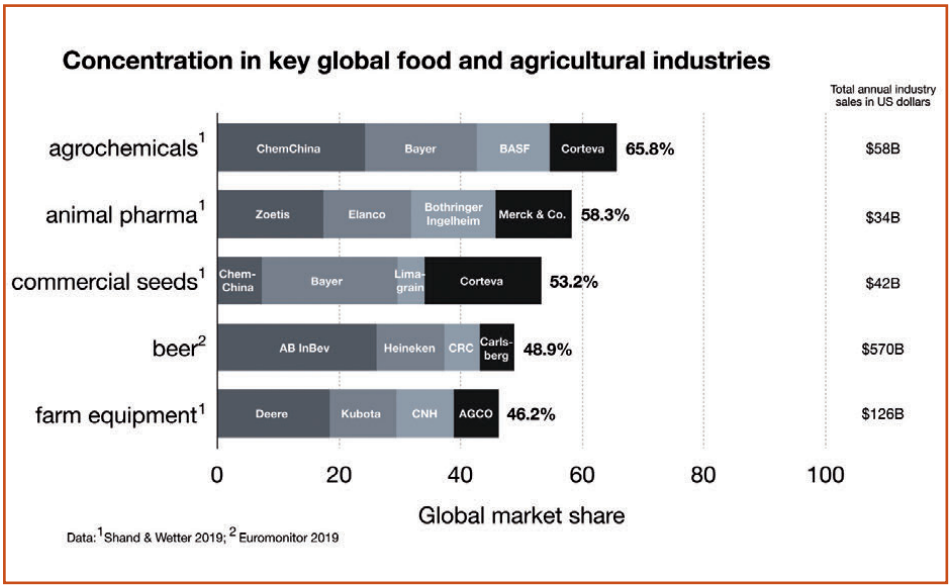
Philip H. Howard & Mary K. Hendrickson

The state of concentration in global food and agriculture industries

In 2009 IAASTD suggested that "business as usual is no longer an option." In the decade since, however, business as usual has continued, and most food- and agriculture-related industries have become even more concentrated. The IAASTD noted that this trend is associated with numerous negative impacts, such as increased marginalization of farmer and rural livelihoods. Yet the market share held by the top four firms **globally** is 40 percent or higher in an increasing number of sectors, despite the fact that this concentration ratio once raised concerns for regulators when observed in much smaller regional and national markets.

In agrochemicals, for example, the top four combine for 65.8 percent of global sales, and for commercial seeds this figure is 53.2 percent. Notably, Bayer [Monsanto], ChemChina [Syngenta] and Corteva [DuPont and Dow] are among the top four in both of these sectors. Animal pharmaceuticals, beer and farm equipment also have global four-firm concentration ratios that exceed 40 percent.

Other industries are rapidly approaching these levels of dominance by large firms. The combined global market share of the top ten firms for sectors that



are more regionally concentrated include more than 50 percent for fertilizers, 18 percent for milk processors, and 10 percent for grocery retailers (Shand & Wetter 2019; IFCN 2019). In some nations the top 4 or fewer firms in key industries combine for more than 90 percent of sales (e.g. grocers in Australia; beer in Brazil, Mexico, Japan, South Africa and South Korea).

The top four agrochemical companies combine for 65.8 percent of global sales.

These figures may underestimate the power of dominant firms, particularly as asset management firms have increased ownership of multiple firms in the same sector in recent years, further reducing incentives to compete (Torshizi & Clapp 2019). Vanguard and BlackRock, for example, have investments in all of the leading firms in a number of food and agricultural industries, such as seeds, animal feed, dairy processing and meat processing.

Although these trends have been resisted, and alternatives had success in certain industries (e.g. organic food, craft brewers), the most successful of these are typically imitated or acquired by dominant firms (Howard 2017). This process may unintentionally open new avenues of growth for dominant firms, thus further reinforcing their power (Bichler & Nitzan 2017).

Policymakers have not only failed to respond to these trends, they have actively contributed to them – most have not sufficiently grasped that transnational agribusiness firms, particularly those emerging from North America and Europe, operate globally to find the cheapest inputs and to sell where they can make the most profit. National competition authorities are now inadequate to address consolidation across borders – those in the EU and the United States, for example, approved the acquisition of Monsanto by Bayer, forcing only limited divestitures. This *de facto* approved the merger globally, essentially forcing the hand of other competition authorities who may have considered other anti-competitive implications.

The top ten fertilizer companies have more than 50 percent of global market share.

In other regions, neo-mercantilist or state capitalism has emerged, with capital's interests even more closely aligned with national geopolitics (Belesky & Lawrence 2019). The governments of China and Brazil, for example, have encouraged food and agriculture firms headquartered in these nations (e.g. meat processors, grain traders, seed/pesticide firms) to expand globally via major acquisitions. Changes to regulations and court decisions have typically increased intellectual property protections and created more barriers to entry for smaller firms, which have subsequently been codified in international trade regimes.

A consolidating food system motivated either by profit or by state interests has failed to sustain farmer livelihoods, address food insecurity and hunger, or to ameliorate the ecological impacts of industrial food production. In fact, profit

and return to shareholders has been prioritized over societal goals of equity, food security and resilience. When forced into global markets, farmers in every region are subsumed into a global intellectual property regime, giving up rights to save seed and to repair their equipment, and losing ownership of their own data. Constrained choices in consolidated markets (Hendrickson 2015) limit their ability to manage crops and livestock to enhance biodiversity (IPES-Food 2017). Opaque feedback loops means global consumers, especially affluent ones, have little understanding of food consumption's impact on farmers, rural communities or distant ecologies. In a consolidated global food system, the focus on productivity and shorter term thinking has created new risks just as humanity faces an unprecedented climate crisis (Nyström et al 2019).

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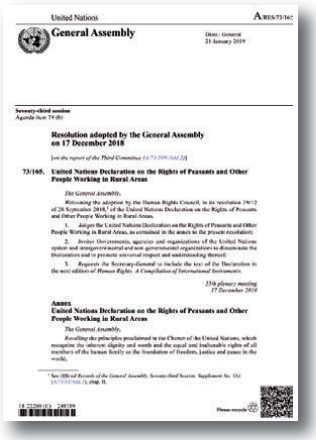
María E. Fernandez

UNDROP – The United Nations declaration on the rights of peasants and other people working in rural areas

The UNDROP Declaration[1] adopted by the General Assembly of the United Nations on December 17, 2018 reaffirms the UN Declarations on the right to development[2], the rights of indigenous peoples[3] and the universality of all human rights. It recognises the special relationship and interaction among peasants and other groups working in rural areas and their contribution to conserving and improving biodiversity as well as their own and world-wide food security.

Article 1 of the Declaration defines peasants as any person who engages in small-scale agricultural production for subsistence and/or for the market, who relies significantly on family, household or other non-monetarized labour and who has a special dependency on the land.


United Nations A/RES/73/165

General Assembly

Resolution adopted by the General Assembly on 17 December 2018

73/165. United Nations Declaration on the Rights of Peasants and Other People Working in Rural Areas

Annex
United Nations Declaration on the Rights of Peasants and Other People Working in Rural Areas

It recognises that peasants and people working in rural areas, including youth and the ageing, are migrating to urban areas due to a lack of incentives and the drudgery of rural life, due to insecure land tenure, discrimination and the lack of access to productive resources, financial services and information. The Declaration is based on a concern that peasants and rural workers are burdened with environmental degradation and climate change and suffer disproportionately from poverty, hunger and malnutrition. This Declaration is an important contribution to the advancement of a paradigm for development where the agency of peasants, indigenous and forest peoples is at its foundation.

The International Assessment of Knowledge, Science and Technology for Agricultural Development (IAASTD)[4] focuses on the contribution of agricultural science and technology to poverty reduction. The findings assess challenges to be met if the 2030 UN Stainable Development Goals (UNSDG)[5] are to be achieved. Our purpose here is to explore how UNDROP reinforces the IAASTD findings and how it can strengthen efforts to reach the 2030 SDGs in rural areas.

Key findings of the IAASTD related to small-scale agriculture and rural communities are directly related to articles in UNDROP. These include:

- the rural population has benefited unevenly from the benefits of production increases;
- many challenges in agriculture will require new strategies that integrate knowledge and technology from the scientific community with that of traditional heritages and local experience to enhance innovation;
- Innovative institutional mechanisms will be required to facilitate the design, adaptation and management of agricultural systems that are ecologically and socially sustainable.

The focus of UNDROP

The Declaration makes explicit that "peasants and other people working in rural areas" have the same rights as the rest of the world's citizenry and that they have a critical role in managing natural resources for food and agriculture and for ensuring food security toward 2050. Specific articles that can sustain, support and complement the findings of the IAASTD include:

• Consultation in policy design *(Article 2.3):* States shall consult and cooperate in good faith with peasants and other people working in rural areas through their own representative institutions, engaging with and seeking the support of those who could be affected by decisions before they are made;

• Women's rights *(Article 4.2):* States shall ensure that peasant women and other women working in rural areas enjoy, without discrimination, all the human rights and fundamental freedoms including: training and education; equal access to financial services, marketing facilities and appropriate technology. They will also be ensured equal access to land and natural resources and equal or priority treatment in land and agrarian reform and land resettlement schemes;

• Organization and Collective bargaining *(Article 9.1):* Peasants and rural workers have the right to form and join organizations, trade unions, cooperatives or any other organization or association of their own choosing for the protection of their interests, and to bargain collectively;

• Food Sovereignty *(Article 15.4):* Peasants and rural workers have the right to determine their own food and agriculture systems (recognized by many States and regions as the right to food sovereignty). This includes the right to participate in decision-making processes on food and agriculture policy and the right to healthy and adequate food, produced through ecologically sound and sustainable methods that respect their cultures.

• Control over seeds technology and medicine *(Article 19):* Peasants and rural workers have the right to seeds, the right to the protection of traditional knowledge relevant to plant genetic resources for food and agriculture and the right to equitably participate in sharing the benefits arising from the utilisation of plant genetic resources for food and agriculture.

Implications of the UN Declaration on challenges identified by the IAASTD

There is no doubt that UNDROP speaks directly to the key findings of the IAASTD. It makes clear that we can no longer look at peasants, indigenous or rural people, foresters or fisherfolk as outsiders or incidental interest groups. They are now, by an international decision, to be guaranteed by all signatories to the UN Charter the same rights that all farmers, small, medium and large-scale, have. As a result, UN Member States are specifically charged with focusing urgently on peasants and other rural people in a different manner than has been customary in many cases. Those states concerned with sustainable agricultural development, have committed themselves further to take measures to:

• Develop new strategies for natural resource and agricultural management to integrate knowledge and technology from the scientific community, traditional heritages, and local experience, in a joint effort with the rural population.

• Innovative institutional mechanisms to facilitate the design, adaptation and adoption of ecologically and socially sustainable agricultural systems need to be designed in a participatory manner, at national and local levels.

• Design and implement processes of consultation that reinforce existing, traditional organizations; increase their representation in local and national fora while encouraging their inclusion of women in leadership. Recognition of collective land rights and diverse resource management systems.

• Foster periodic events at local, state and national level that give public recognition to the historical and continuing role in land, forest and biodiversity management that explicitly "award" contributions of rural people – men and women – to knowledge and technology generation.

Below are two examples of efforts to support rural communities in the management of natural resources upon which they – and we – depend.

Guatemala: Association of Forest Communities of Petén (*ACOFOP*)[6]

The Association of Forest Communities of Petén was founded in 1997. By 2000 its support to rural communities in the Petén had resulted in a 25 to 40 year concession by the government allowing for community management of some 500,000 hectares of forests located in the Maya Biosphere Reserve (MBR). For more than two decades, ACOFOP has worked to develop a sustainable and comprehensive forest management model, through which successful companies have been created in the certified timber market, as well as in the commercialisation of non-timber forest products, such as palm of xate, honey, chewing gum and Ramón seed. It also ventures into the tourism sector through the provision of guidance services in the different heritage sites.

Strategies devised as part of the politics of participation practised by ACOFOP include the provision of direct funding to community institutions and enabling community forestry entities to gather information, monitor progress and diagnose their own issues. The objective is to cultivate learning communities with cultures of questioning that actively include women and especially young people. Their Accompaniment strategy is not about "helping" poor forest communities, but focuses on the collectivisation of claims to tenure and of capacities to meet the technical and legal demands of community forestry. An implicit principle of "Accompaniment" is that of learning while complex socio-cultural negotiation is taking place at every scale.

The communities who are members of ACOPOF have faced constant challenges over the years including: conflict between the rights of community members and non-members; failure of member communities to fulfil obligations and how to deal with the apparent absence of state support while faced with the incursion of illegal land appropriations for the establishment of cattle ranches affecting 30 to 50% of the concessionary. ACOFOP fostered alliances at national and international level, enabling effective campaigning which in turn guaranteed a renewal of the concessions in 2021.[7]

As Milner et.al. (2019) have pointed out, successful community forestry in the Maya Biosphere Reserve is tied to the development of institutions that learn through negotiation, and embed learning into their regulatory practices. Each area of negotiation involves navigating specific tensions; between keeping rules and changing them; between establishing unity and linking diverse interests; between listening carefully and speaking persuasively; between defending territorial rights and addressing internal power dynamics. These tensions constantly threaten to undo the possibility of collective action, but they also keep participation open, fostering inquiries that lead to enhanced participation.

CGIAR Research Program on Forests, Trees and Agroforestry[8]

In 2012, the Forest Genetic Resources team at Bioversity International carried out a centre-wide assessment of its capacity to carry out gender-sensitive research to identify policies, technologies and practices that contribute to enhanced gender equity in access, use and management of forests and trees, and the distribution of associated benefits internationally.[9]

In parallel, it carried out a Gender Fellowship Program that supported three female and two male researchers from West and Central Africa, and Central, South, and Southeast Asia with research grants, capacity strengthening workshops (in theory, methods and use of tools) and mentoring.[10] Below we share a window into the use of gender-responsive participatory research by one of the fellows:

In the Central Western Ghats of India forests are owned by the state Forest Department (FD) and can be classified as protected forest, reserve forest and minor forests. Degraded forests in reserve forest and minor forest zones are managed by Village Forest Committees. These are registered organizations that bring together the FD with local communities under India's Joint Forest Management program. The research was carried out in three villages with high forest cover, because of the wide variety of non-timber forest products used by the communities, their large sociocultural and ethnic diversity, high local dependency on forest resources and villagers' willingness to participate in the research.

UN Member States are now charged with focusing on peasants and rural workers in a different manner than before.

Women and men participants from three villages actively engaged in knowledge mapping activities. Participants found the competitive angle of identifying which groups had most knowledge about the different topics identifies particularly motivation. They were keen to complete the exercises even when these took over 2 hours. Additionally, many participants from disadvantaged ethnic groups as well as illiterate and younger women explained that it was their first experience speaking in front of a mixed gender and multi-ethnic group in plenary. An elder woman from the Naik community in Salkani explained that, 'this is the first time that most of us, both men and women, spoke out in front of a group of people. Initially we were shy and hesitant, but after a while it brought out confidence within and among us.' Participants expressed that bringing differentiated sets of knowledge together increased the knowledge held individually and collectively, ensured that different perspectives could be recognised and valued, and provided a more comprehensive picture of the breadth of local knowledge on NFTs.

Suggestions on how to move forward

These examples allude to both the advantages of working with differentiated gender, age, cast and ethnic groups in a process of social learning that can enrich policy and research agendas that respect the UN Declaration on the Rights of Peasants and other People Working in Rural Areas as well as the challenges that representation, consultation and participation imply. For those of us who acknowledge the need for a development paradigm shift, these challenges will include questioning one's own professional training and risking professional credibility among those colleagues determined to remain part of the status quo. The task at hand requires us to continue to facilitate actions being taken internationally as well as at state, regional, and community levels in a masterful interdisciplinary and inter-institutional effort. Specific actions require:

- Building institutional capacity to do gender-responsive participatory research and consultation at all levels;
- Carrying out systematic consultation with organised rural people and their representatives in policy design;
- Increasing access by women to land, information, educational services and representation in community, regional and national organizations;
- Supporting the recognition and strengthening of community organizations respecting their history and socio-cultural factors that affect their processes and procedures for participation and decision-making;
- Creating mechanisms whereby rural people can participate in policy-making decisions;
- Protecting customary land rights and collective natural resource management systems;
- Documenting and providing public recognition for traditional knowledge relevant to the management of plant genetic resources;
- Increasing the distribution of the benefits from plant genetic resource use among those who have generated and cared for them historically.

One of the most important challenges we face is to provide opportunities for small farmers to have a significant voice at the table as we look for ways to design and implement policies that effectively bring us to more sustainable food production for the future. In Peru last year, 32,000 small farmers made their voice heard and the Congress passed a law recognising them as certified ecological producers. One year later however, the law is yet to be implemented as

larger and more powerful and uncertified farmers have been able to slow down the process. Over the past ten years we have come a long way in building support for a more sustainable resource management agenda. We will need to find better ways to allow the voices of smaller farmers, fisherfolk and indigenous communities to be heard.

Endnotes

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Ben White & Jan Douwe van der Ploeg

Changing demographies and smallholder futures

A vibrant, earth-friendly smallholder-based agriculture depends – among other things – on the willingness of young rural men and women to take up the challenge of farming. In the past decade since IAASTD's publication, three interrelated aspects of changing rural demographics have been a cause for concern in relation to the prospects of smallholder-based farming futures.

The first is the ageing of farming populations, all over the world. In many countries (high, middle and low income) in a timespan of only three decades the proportion of farmers under age 35 has halved while those aged 55 and over have doubled. Second is the widely-reported aversion of today's relatively well-educated young rural men and women to farming futures. And third is these young rural people's increasing spatial and sectoral mobility (White, 2020).

Young people's aversion to farming is often seen as a main cause of the rising average age of farmers. But is it true that young people no longer have sufficient interest in engaging in farming? This assumption is largely based on data constructed by state administrative systems (Ploeg, 2013), and this can create its own problems. For example, there may be many farms that are legally still owned by 'an old patriarch' but which, in practice, have been already run for quite some time by one or more of the children. In national statistics, such farms appear to be run by an aged farmer without a successor and doomed to disappear. Then there is the opposite case, of the many young men and women who would like to start farming but cannot get access to the land (Rete, 2012: 36), some of whom migrate elsewhere in order to make their dream come true. They too do not appear in the statistics. In summary, farms with youngsters and youngsters wanting to farm are too often filtered out of statistics.

Over the past 30 years, the proportion of farmers under age 35 has halved.

We also have to take into account that officially produced statistical trends are *averages*, which can conceal important countertendencies. We will briefly discuss here two such countertendencies. Organic agriculture, at least in the Northwest of Europe, and perhaps also elsewhere, offers such a countertendency. The percentage of organic farms that pass to the next generation is nearly twice as high as conventionally managed farms (Vijn, 2010: 22-23). Even more intriguing is that a substantial number of organic farms give birth to two or more new

organic farms that are run by the children. This is easy to explain: on the whole incomes are better in organic farms, debts are lower and the people involved experience more joy and satisfaction in their jobs. However, all this escapes from statistics.

Another countertendency resides in the so-called *inflow*. Mathematically, the decrease in the number of farmers is the aggregate of the outflow and the inflow: the outflow represents the number of farmers who stop farming (and who are not succeeded by one of their heirs) and the inflow is the number of people who enter the sector and start farming. Census data give the difference between the two, but normally do not detail the specifics of either.

Twice as many organic farms pass to the next generation than conventional farms.

There are a few, exceptional, data bases that allow us to assess both the inflow and the outflow. These show intriguing tendencies and countertendencies (Ploeg, 2017). In 1980, the Netherlands had 71,426 farms with grazing animals. Ten years later this number had declined by 7,012 (i.e. circa 10%). This reduction was the *net-result* of an outflow of 16,353 farms and an inflow of 9,341. If we only look at the net result, the overall reduction of 7,012 farms, this almost automatically reaffirms the thesis that farms are *inevitably* disappearing. But a closer look shows that there is a large inflow, more than the aggregate decline, that includes young as well as elder people starting to build a farm. Studying this inflow would generate, we believe, useful insights on how these people can be supported in creating and further developing a farm.

Comparing levels of inflow in the Netherlands for different decades shows a slowdown in this inflow. This evidently reflects changing institutional and economic conditions. If incomes were higher, working hours less, regulations less asphyxiating, and rural services better, the trend could probably be reversed. Here again it applies that a careful empirical inquiry into these evolving conditions and their interaction with the everyday life experiences of young people could help to identify critical levers for change.

In surveys of rural youth aspirations in Asia, Africa and Latin America, when young men and women are asked some form of the question "what would you like to do when you grow up?", they overwhelmingly mention secure, salaried work while farming comes far down on the list. However, if the same surveys ask "what would make farming an attractive option for you?" farming emerges as a possible option – if land and inputs are available and if farming is at least partly commercially oriented and combined with other income sources in pluriactive livelihoods. Young people's desire for an economic existence independent from their parents is strong, and they express a clear understanding of the constraints which make access to land and to successful farming difficult, at least while they are still young.

It is not surprising, then, that so many rural school-leavers opt for trajectories of migration and non-farm work. But this is not necessarily a once-for-all, permanent decision. Many of today's "young farmers" are in fact former out-migrants who have then returned to the village and to farming (White, 2020: Ch. 5).

Global awareness of the economic, social and environmental advantages of smallholder farming over industrial farming is evidenced by the UN's International Year of the Family Farmer (2014) and the recent launching of the UN Decade of Family Farming 2019-2028. "Putting family farming and all family-based production models at the focus of interventions", according to FAO, "will contribute to a world free of hunger and poverty, where natural resources are managed sustainably, and where no one is left behind" (FAO-IFAD, 2019: 8). Most governments, however, have withdrawn more and more from their role of supporting small-scale farmers and rural development generally (HLPE 2013), and continue to give free rein to large-scale agribusiness ventures.

Young people's desire for an economic existence independent from their parents is strong.

A generationally sustainable revitalization of smallholder farming means recognizing rural youth not as instruments of development and growth ("human capital"), but as subjects, actors and citizens. It means providing land and other agrarian resources to young men and women would-be farmers while respecting the interests and needs of the older generation. There are many examples of government and NGO programmes aiming to promote the transfer of land between generations (not necessarily between parents and children), or to provide young would-be farmers with access to unused or public land at low cost (White, 2020: 131-2). In Brazil's Landless Workers Movement (MST), systems of collective tenure and communal governance and explicit recognition of young people's role in farming have provided both economic and non-economic benefits for young people, and improved the present and future livability of the Brazilian countryside (Gurr, 2017: 256).

Initiatives to support young farmers should include both, those from farming backgrounds and newcomers, male and female, and should take into account the characteristic patterns of youth trajectories today, especially their multidirectional mobility and pluriactive livelihoods combining farm and non-farm incomes. This requires creative promotion of opportunities for young rural men and women to engage in farming, and investment in infrastructures making rural areas attractive places for young men and women to live and work.

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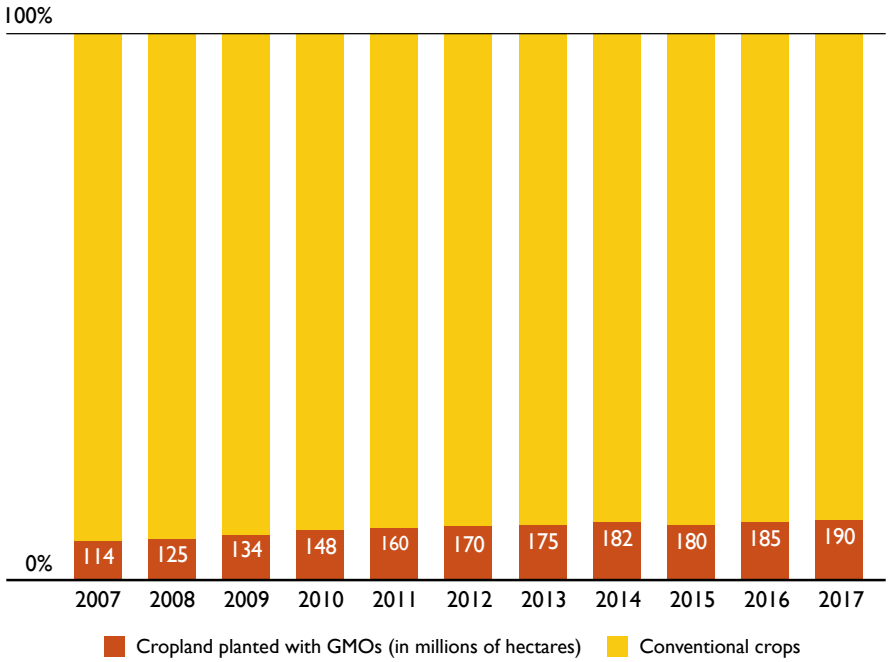
Area planted with GMOs



Global area planted with genetically modified crops (GMOs) in millions of hectares and as a percentage share of total cropland (arable land and land under permanent cultures)

Keeping scale in perspective

Despite the hype and controversy about genetically modified crops, their importance on a global scale remains limited and cultivation on a large scale takes place in just a few countries. The share of the total cropland planted with genetically modified crops has increased only slightly over the past decade, from 8% in 2007 to 12% in 2017. This equates to the total area planted with GM crops increasing from 114.3 million hectares in 2007 to 189.8 million hectares in 2017. For 2018, biotech lobby organization ISAAA, which provides the only publicly available global database on the adoption of GMOs, reports a 1% increase to 191.7 million hectares. Just five countries accounted for more than 90% of the entire area cultivated with GMOs: the United States planted 75 million hectares of GM crops in 2018, followed by Brazil with 51.3 million hectares, Argentina (23.9m hectares), and finally Canada and India with 12 million hectares respectively.

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Kate Brauman & Bob Watson

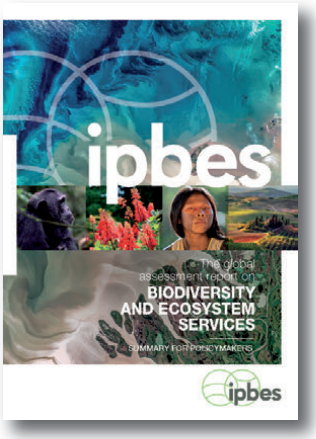
Agriculture and biodiversity

In 2019, IPBES published its "Global Assessment report on Biodiversity and Ecosystem Services"[1], the first global assessment of this kind in almost 15 years and the first ever carried out by an intergovernmental body. It identifies key drivers of change in nature, its societal implications and possible actions that can be taken to address these changes.

Since the Intergovernmental Assessment of Agricultural Science and Technology for Development (IAASTD) was published ten years ago there has been a significant increase in our scientific understanding of how agricultural practices have affected biodiversity and how the loss of biodiversity is impacting agriculture. The evidence is unequivocal that most agricultural practices are unsustainable and have been a major driver of the loss of terrestrial biodiversity (IPBES 2019.

Trends in nature's contributions to people[2] and how they are affected by biodiversity loss

People depend on nature, and while some core contributions of nature have increased, the global assessment of IPBES found that most of nature's contributions are in decline. Nature plays a critical role in providing many material goods, and, since 1970, agricultural production, fish harvest, bioenergy production and harvest of materials have increased (IPBES 2019: 2.3.5). The value of agricultural crop production, $2.6 trillion in 2016, has increased approximately threefold since 1970, and raw timber harvest has increased by 45 per cent, reaching some 4 billion cubic meters in 2017, with the forestry industry providing about 13.2 million jobs (FAO 2019). In addition, nature, through its ecological and evolutionary processes, sustains the quality of the air, fresh water and soils on which humanity depends, distributes fresh water, regulates the climate, provides pollination and pest control and reduces the impact of natural hazards (IPBES 2019: 2.3.1). However, most of these regulating contributions of nature, as well as its non-material contributions – inspiration and learning, physical and psychological experiences, and supporting identities – are in decline (IPBES 2019: 2.3.5). Declines in 14 of the 18 categories of nature's contributions to people evaluated (Figure 1) indicate that gains in material contributions are often not sustainable. For example, land degradation has reduced productivity in 23 per cent of the global



terrestrial area (IPBES 2018), and between $235 billion and $577 billion in annual global crop output is at risk as a result of pollinator loss (IPBES 2016). Moreover, declines in the diversity of nature reduce humanity's ability to choose alternatives in the face of an uncertain future.

Biodiversity is particularly important for agriculture, and declines in biodiversity threaten agriculture in a variety of ways (IPBES 2019: 2.2.3.4.3). For example, more than 75 percent of global food crop types, including fruits and vegetables and some of the most important cash crops, such as coffee, cocoa and almonds, rely on animal pollination (IPBES 2016). Globally, local varieties and breeds of domesticated plants and animals are disappearing (IPBES 2019: 2.2.5.2.6). This loss of diversity in cultivated crops, crop wild relatives and domesticated breeds poses a serious risk to global food security by undermining the resilience of many agricultural systems to threats such as pests, pathogens and climate change. Fewer and fewer varieties and breeds of plants and animals are being cultivated, raised, traded and maintained around the world, despite many local efforts, which include those by indigenous peoples and local communities (IPBES 2019: 2.2.4). By 2016, 559 of the 6,190 domesticated breeds of mammals used for food and agriculture (over 9 per cent) had become extinct and at least 1,000 more are threatened (FAO 2016). In addition, the conservation status of wild relatives of domesticated mammals and birds is worsening, and many crop wild relatives that are important for long-term food security lack effective protection.

Land degradation has reduced productivity in 23 per cent of the global terrestrial area.

There are often trade-offs in the production and use of nature's contributions (IPBES 2019: 2.3.5). Giving priority to the production of food, feed, fiber and bioenergy can result in ecological changes that reduce other contributions of nature to quality of life, including regulation of air and water quality, climate regulation and habitat provision, as well as non-material contributions. Synergies also exist, such as sustainable agricultural practices that enhance soil quality, thereby improving productivity and other ecosystem functions and services such as carbon sequestration and water quality regulation. In addition, benefits and burdens associated with the production and use of nature's contributions to people are often distributed unequally across space and time and among different segments of society, social groups, countries and regions. Some of these tradeoffs may benefit some people at the expense of others, particularly the most vulnerable, as may changes in technological and institutional arrangements. For example, although food production today is sufficient to satisfy global needs, approximately 11 per cent of the world's population is undernourished, and diet-related disease drives 20 per cent of premature mortality, related both to undernourishment and to obesity (FAO 2017).

559 of the 6,190 domesticated breeds of mammals used for food and agriculture (over 9 per cent) had become extinct by 2016.

Figure 1. Global trends in the capacity of nature to sustain contributions to good quality of life from 1970 to the present, which show a decline for 14 of the 18 categories analyzed. Data supporting global trends and regional variations come from a systematic review of over 2,000 studies (IPBES 2019: 2.3.5.1). For many categories, two indicators are included that show different aspects of nature's capacity to contribute to human well-being. Figure from IPBES 2019 [1].

Most of nature's contributions are co-produced with people, but while anthropogenic assets – knowledge and institutions, technology, infrastructure and financial capital – can enhance or partially replace some of those contributions, some are irreplaceable (IPBES 2019: 2.3.2). Loss of diversity, such as phylogenetic and functional diversity, can permanently reduce future options, such as wild species that might be domesticated as new crops and be used for genetic improvement (IPBES 2019: 2.2.3.4.3). People have created substitutes for some contributions of nature, but many of these are imperfect or financially prohibitive (IPBES 2019: 2.3.2). For example, high-quality drinking water can be achieved either through ecosystems that filter pollutants or through human-engineered water treatment facilities. Similarly, coastal flooding from storm surges can be reduced either by coastal mangroves or by dikes and sea walls. In both cases, however, built infrastructure can be extremely expensive, incur high future costs and fail to provide synergistic benefits such as nursery habitats for edible fish or recreational opportunities. More generally, human-made replacements often do not provide the full range of benefits provided by nature.

Agriculture, biodiversity and climate change

Agriculture is a key driver of global changes in nature over the past 50 years, as discussed in IAASTD (IAASTD 2009). The direct drivers of changes in nature with the largest global impact have been (starting with those with most impact): changes in land and sea use, including agriculture; direct exploitation of organisms; climate change; pollution; and invasion of alien species (IPBES 2.2.6). Those five direct drivers result from an array of underlying causes – the indirect drivers of change – which are in turn underpinned by societal values and behaviors that include production and consumption patterns, human population dynamics and trends, trade, technological innovations and local through global governance (IPBES 2019: 2.1).

The average per capita consumption of materials (e.g., plants, animals, fossil fuels, ores, construction material) has risen by 15 per cent since 1980 (IPBES 2019: 2.1). Producing, consuming and disposing of these materials has generated unprecedented impacts (IPBES 2019: 2.1): since 1980, greenhouse gas emissions have doubled, raising average global temperatures by at least 0.7 degrees Celsius, while plastic pollution in oceans has increased tenfold. Over 80 per cent of global wastewater is being discharged back into the environment without treatment, while 300–400 million tons of heavy metals, solvents, toxic sludge and other wastes from industrial facilities are dumped into the world's waters each year. Excessive or inappropriate application of fertilizer can lead to run off from fields and enter freshwater and coastal ecosystems, producing more than 400 hypoxic zones which affected a total area of more than 245,000 km^2 as early as 2008. The rate of change in the direct and indirect drivers differs among regions and countries.

While, globally, climate change has not been the most important driver of the loss of biodiversity to date, it is projected to be as, or more, important than the other drivers in the coming decades (IPBES 2019: 2.1.17). In addition, climate change will interact with other drivers, exacerbating their impact. Climate change adversely affects genetic variability, species richness and populations, and ecosystems. In turn, loss of biodiversity can adversely affect climate, for example, deforestation and conversion of grasslands and mangroves increases the atmospheric abundance of carbon dioxide. Climate change, through changes in temperature, precipitation and pests, also has an adverse impact on agricultural production. Therefore, the issues of climate change, loss of biodiversity and agriculture must be addressed together.

Limiting human-induced climate change requires transitioning to a low-carbon economy as rapidly as possible, and not just from the energy sector. It is critical that agricultural emissions, particularly methane and nitrous oxide, are reduced. It is equally critical that agricultural production becomes more climate resilient by ensuring crops are more temperature, drought, salinity and pest resistant.

Potential solutions

We personally think that protecting and improving our environment is critical. To do so, we must engage with a broad range of people, especially indigenous and local communities. We need to understand how they are impacted and develop adaptation strategies together. A technological fix imposed from above is no solution. One key area we're passionate about is changing the food system, including removing agricultural subsidies, reducing food waste, and reconsidering diets. In addition, making the agricultural sector both more climate friendly and more climate resilient will be a huge challenge, and one we look forward to seeing a diverse community take on.

Urgent and concerted efforts are needed to address the direct drivers together with the root causes of nature deterioration, such as poor governance, unsustainable economic systems, social inequalities, lack of cross-sectoral planning and appropriate incentives, and unsustainable social narratives and values (IPBES 2019: 6).

Nature and the benefits it provides can be conserved, restored and used sustainably while simultaneously meeting other global societal goals. Feeding humanity and enhancing the conservation and sustainable use of nature are complementary and closely interdependent goals that can be advanced through sustainable agriculture, aquaculture and livestock systems, the safeguarding of native species, varieties, breeds and habitats, and ecological restoration. Specific actions include promoting sustainable agricultural practices, such as good agroecological practices, multifunctional landscape planning and cross-sectoral integrated management that supports the conservation of genetic diversity and associated agricultural biodiversity. Further actions to simultaneously achieve

food security and protect biodiversity are context-appropriate climate change mitigation and adaptation actions that incorporate knowledge from various systems, including the sciences and sustainable indigenous and local practices. These practices include avoiding food waste, providing storage and transport infrastructure to limit post-harvest losses, empowering producers and consumers to transform supply chains and facilitating sustainable and healthy dietary choices. As part of integrated landscape planning and management, prompt ecological restoration emphasizing the use of native species can offset current degradation and save many endangered species, but it is less effective if delayed.

As noted earlier, there has been a world-wide decline in the populations and diversity of wild pollinators and hence pollination services (IPBES 2016). This has been accompanied by seasonal colony loss of western honey bees in some regions of the world. Therefore, it is important to maintain healthy pollinator communities through (i) agroecological farming practices, (ii) strengthening existing diversified farming systems, and (iii) investing in ecological in- frastructure by protecting, restoring and connecting patches of natural and semi-natural habitats throughout productive agricultural landscapes. These need to be complemented by reducing the risk of lethal and non-lethal effects of pesticides, particularly insecticides such as neonicotinoids, on pollinators. This could be facilitated by the use of integrated pest management. Honey bees need to be protected from a broad range of parasites, including Varroa mites, by placing greater emphasis on hygiene and control of pathogens.

We are passionate about changing the food system, removing agricultural subsidies, reducing food waste, and reconsidering diets.

Another key set of key actions include steering away from the current limited paradigm of economic growth and the use of Gross Domestic Product (GDP) as a measure of economic growth to one which incorporates natural capital into national accounting systems, recognizes both market, non-market and social values of biodiversity in decision-making, eliminates harmful agricultural, energy and transportation subsidies, provides incentives for sustainable production and consumption, embraces a circular economy and recognizes the social costs of environmental degradation.

Recognizing the knowledge, innovations and practices, institutions and values of indigenous peoples and local communities, it is critical to ensure their inclusion and participation in environmental governance. Doing so often enhances their quality of life while promoting nature conservation, restoration and sustainable use, which is relevant to broader society. Governance, including customary institutions and management systems and co-management regimes involving indigenous peoples and local communities, can be an effective way to safeguard nature and its contributions to people, incorporating locally attuned management systems and indigenous and local knowledge. The positive contributions of indigenous peoples and local communities to sustainability can be facilitated

through national recognition of land tenure, access and resource rights in accordance with national legislation, the application of free, prior and informed consent, improved collaboration, fair and equitable sharing of benefits arising from the use of resources and co-management arrangements with local communities.

Endnotes

1 See at https://ipbes.net/global-assessment

2 The IPBES global assessment predominantly used the term "nature's contributions to people," which is more inclusive than the common term "ecosystem services"

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Jack A. Heinemann

Assessment of modern biotechnologies

The IAASTD concluded that biotechnology was an essential part of transitioning agriculture from either subsistence or industrial (or other high input) to sustainable and productive. Biotechnology refers to the manipulation of living organisms through activities as diverse as breeding and fermentation to the use of tissue culture, irradiation, genomics and genetic engineering. The significant and ongoing contribution of biotechnology to the improved genetics and performance of plants, animals and microorganisms used in agriculture has altered the need for and type of inputs into agroecosystems, making enormous impacts on both productivity and social structure.

The most contentious biotechnologies are of the category called 'modern biotechnology'.[1] Modern biotechnologies including genetic engineering have made profound contributions to fundamental genetic science and medicine, at least as a research tool. However, in agriculture in particular, there has been a large scale although globally asymmetric adoption of GMOs, almost exclusively plants, too.

Most traits of agricultural importance are multigenic. For example, drought stress changed expression of over 10,000 genes in sorghum plants.

The use of GM plants in agriculture remains a small proportion of world agriculture and a minority proportion of the agriculture in all countries except for a few in South America. Adoption of GM agriculture globally as well as the number of GM plants that are commercially available, has increased in the last decade, but modestly. In some places, it has also disappeared. The assessment of the IAASTD was that such forms of modern biotechnology were highly specialised. This made them of limited value to small-scale farmers especially in developing countries, and these are the farmers that are the major food producers.

The IAASTD acknowledged that prevailing GM plants had benefits. However, these were mainly observed when comparing their use to other high input mainly monoculture agroecosystems and ongoing uncertainties of sustainability and safety confined their adoption to mainly commodity crop plants for industrial systems of feed, fuel and fibre and mainly countries in the Americas with large commodity crop monocultures and short or no rotation cycles.

Meanwhile, newer tools of gene technology have become available. These tools include, among others, regulatory RNA molecules, site-directed nucleases (SDN) and chemical and mechanical vectors that efficiently transport RNA, DNA and protein molecules into cells and organisms.

Regulatory RNA

Regulatory RNA molecules alter the expression of genes. The most common type of regulatory RNA molecule is a double-stranded RNA (dsRNA). Nearly all organisms so far tested use dsRNA gene regulatory pathways. In eukaryotic organisms, such as fungi, plants and animals, dsRNA molecules cause RNA interference (RNAi). Most often this causes gene silencing. RNAi may be reversed within a generation, or in some cases leads to intergenerational effects (Heinemann 2019).

New regulatory RNAs may be introduced into an organism by introducing into a cell a fragment of DNA that is transcribed within the organism with the resulting product forming a dsRNA. This strategy is the same as creating GMOs using recombinant DNA techniques. The first such commercial pesticidal plant has been approved for use in the United States. In addition, new chemistries and mechanical methods in research and pre-commercial stages allow the dsRNA to be directly introduced into cells or organisms at concentrations that are sufficient to initiate RNAi in the exposed organism or cause dsRNA-mediated epigenetic changes that are intergenerational (Heinemann 2019).

Site-directed nucleases

SDNs are commonly known for procedures referred to as gene/genome editing. SDNs have the potential to increase the rate at which intended modifications are created at intended locations. SDNs such as ZFNs or TALENs may be constructed to recognise a target sequence of nucleotides in a DNA or RNA molecule, or as in the case of CRISPR/Cas, the SDN recognises its target using an oligonucleotide (DNA or RNA) co-factor.

SDNs may be used to break the phosphodiester bonds between nucleotides in DNA, resulting in the initiation of repair of the damage and a high rate of mutation at the repair site. The outcome may be a change as small as a single nucleotide substitution to as large as a significant deletion or insertion of new nucleotide sequences. The repair mechanisms may make use of any available DNA to repair the damage, resulting in insertion of intended fragments of DNA or DNA from other sources, such as contaminants in the reagents (Ono et al. 2019).

Genome editing techniques are not new (Itakura and Riggs 1980), but the SDNs have made it possible to apply the techniques to a wider range of species with a greater target flexibility. Applied as an engineered gene drive, an SDN has a level of automation that was not available to earlier tools.

Environmental transformation technologies

Gene technologies are inseparable from the technologies that move nucleic acids, such as dsRNA and guide oligonucleotides for SDNs, and sometimes proteins, such as SDNs, into cells and organisms. The flexibility and proposed power

behind the capacity to alter traits using RNA and SDNs comes from a codeveloping revolution in chemistry and mechanical manipulation that increases the scale of application. The technology for transferring RNA, DNA and proteins into living tissues and cells has advanced to the stage where genetic engineering can now be done using topical or "spray-on" agents at landscape scales, with rapid repeat exposures or manipulation of multiple targets (for a large list of examples, see Heinemann and Walker 2019).

Evaluation

Fundamentally, the IAASTD saw that the contribution of modern biotechnologies to agriculture was out of balance with approaches that emphasised the multifunctionality of the agroecosystem. The new capacities also have not eliminated socio-economic, environmental or human health concerns, though they may shift the risk to hazards that have not been considered for older products (CBD 2017).

It is unlikely that the new modern biotechnology tools that have become more widely available for commercial deployment in agriculture will significantly alter the conclusions of the IAASTD. Core choices made by developed economies to increasingly devolve research and development to the private sector, and therefore to the structures and incentives that drive the private sector (Quist et al. 2013), are expected to groom applications of these new tools in the same way as the previous ones. The ultimate market concentration that results, reduces options for agriculture in both developed and developing countries because modern biotechnology has mainly served green revolution-type demands on breeding to fit high input and uniform agroecosystems.

There is no convincing evidence that the new generation of tools will change the role of modern biotechnology. However, some of the advances in related technologies, such as in "omics technologies" used to survey the changes introduced into organisms made using gene technologies, could help to advance characterisation of GMOs intended for use in the environment (NASEM 2016). The traits that are being developed for commercial release so far are either minor variants (e.g. non-browning apple and potato) or relevant to pesticide use (e.g. environmental transformation technologies). The interest in applying the techniques to improved nitrogen fixation in non-legumes, drought and other abiotic stress tolerances and climate change mitigation through animal genetics is high, but the evidence of significant progress is no greater than with the recombinant DNA techniques.

The underlying challenge to accelerating trait development through gene technology is that most traits of primary agricultural importance are multigenic and/or quantitative and responsive to the environment. For example, expression of over 10,000 genes, >40% of the genome, changed when sorghum plants were drought stressed (Varoquaux et al. 2019). The change is dynamic, occurring

at time scales of only days. Moreover, the changing environmental conditions alter the associated microbiota (Xu et al. 2018). Even though the new tools can be applied to multiple targets at once, or applied in serial applications or in the environment on multiple species simultaneously, they do not have the ability to cause the intended and only intended changes in the function and expression of many genes in crops and livestock at relevant time scales, much less the genes of the many microorganisms associated with them.

It is unlikely that the new modern biotechnology tools will significantly alter the conclusions of the IAASTD.

Breeding is a foundational tool for agriculture that can be assisted by the tools of modern biotechnology without relying upon GMOs (Gilbert 2016). Breeding alone does not address the diversity of needs of farmers, especially subsistence farmers who may use modern elite varieties but have lower yields because of the environmental, social and economic constraints on them and their agroecosystems (Leakey 2019). While maximising potential yield is often the focus of discussions on biotechnology, social and environmental constraints determine actual yield in farmers' fields (Leakey 2019). The multifunctionality of agriculture requires policy approaches that also address poverty and livelihoods reaffirming the IAASTD conclusion that an integrated agroecological approach is the most promising for climate change mitigation and improving sustainability.

Abbreviations

CRISPR	Clustered Regularly Interspaced Short Palindromic Repeats
dsRNA	double-stranded RNA
GM	Genetically Modified
GMO(s)	Genetically Modified Organism(s)
DNA	Deoxyribonucleic Acid
RNA	Ribonucleic Acid
RNAi	RNA interference
SDN	Site Directed Nuclease
TALEN(s)	Transcription Activator-Like Effector Nuclease(s)
ZFN	Zinc Finger Nuclease

Endnote

1 For definitions please refer to the Convention on Biological Diversity, Cartagena Protocol on Biosafety and Codex Alimentarius.

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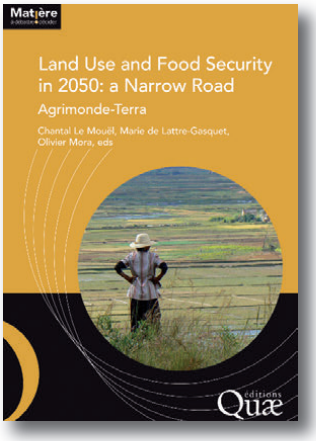
Marie de Lattre-Gasquet

Land use and food security in 2050: a narrow road – Agrimonde-Terra

In 2018 CIRAD, a French research centre working with developing countries to tackle international agricultural and development issues and INRA, the French public research institute dedicated to agricultural science, launched a foresight process relating to 'land use and food security in 2050', called Agrimonde-Terra[1]. This process mobilized around 80 international experts in thematic workshops, and a Scenario Advisory Committee to explore the complex interactions between land use and food and nutrition security. Five scenarios for 14 world regions were produced, drawing lessons on land use and food security and making a range of policy recommendations.

Agrimonde-Terra is now a tool for dialogue and learning for use by decision-makers, food producers, non-governmental organizations and researchers. By using the Agrimonde-Terra method, scenarios for land use and food security in Tunisia[2] were successfully prepared and, following this, on-going trends relative to land use in sub-Saharan Africa[3] have been identified.



Scenarios: changes in land use and their consequences for food security

The **first scenario** "Land use driven by metropolization" (**Metropolization**) links the development of megacities at a global level with a nutrition transition led by global agri-food companies selling ultra-processed foods. This scenario is seen in a global context of development through market forces and rapid climate change, leading to the marginalization of small farmers.

The **second scenario** "Land use for regional food systems" (**Regionalization**) relates to the increase of medium-size cities and their networking with rural areas to the emergence of regional food systems. These systems are based on family farming and traditional foods, and a set of regional agreements.

The **third scenario** "Land use for multi-active and mobile households" (**Households**) links strong individual mobility between rural and urban areas and the development of farm and off-farm employment, to the emergence of hybrid diets. This scenario is based on traditional and modern value chains in a globalized world, where family farms and cooperatives are major actors in land use.

The **fourth scenario** "Land use for food quality and healthy nutrition" (**Healthy**) assumes that due to the increasing cost of malnutrition, a radical move towards healthy diets occurs. This move is fueled by global cooperation and public policies in the context of climate change stabilization and implies that there is a reconfiguration of the agricultural system which is backed by new alliances between stakeholders.

The **fifth scenario** "Land as commons for rural communities in a fragmented world" (**Communities**) assumes that in a context of repeated multiple crises, development based on small towns and rural communities occurs. This focus is then placed on managing common property in agriculture in order to ensure food security.

The scenarios listed above do not have the same consequences on the five dimensions of land use (listed below) nor on the availability of food. A comparison between them therefore helps to draw lessons for the future.

Lessons learnt include the point that unless there is a major increase in the economic and social performance of food systems in some regions, notably in India and sub-Saharan Africa, ensuring world food availability in 2050 will involve expanding the world's agricultural land area to the detriment of forest areas, with major differences between scenarios. It also demonstrates that trade of agricultural products will play a key role in improving world food access in 2050, and that increasing food and nutritional diversity towards healthier diets in 2050, while limiting agricultural land expansion and deforestation will require greater diversification in cropping and livestock systems.

To achieve healthier diets in 2050, more diverse cropping and livestock systems are needed.

At least two scenarios are clearly not able to ensure sustainable world food and nutrition security in 2050: the first "Metropolization" scenario and the fifth "Communities" scenario. Furthermore, two scenarios have ambiguous results: the "Regionalization" and the "Households" scenarios. Only the "Healthy" scenario seems likely to be able to meet the objective of world food and nutrition security in 2050 (reducing not only overnutrition and related diseases, but also undernutrition). This could be achieved at the cost of a limited expansion in agricultural land area at the world level. However, in this scenario, there are potential tensions between the objectives of food security and climate change stabilization, unless agroforestry and farming practices relating to agroecology and sustainable intensification are adopted.

Main novelties of Agrimonde-Terra

- The **five complementary and interlinked dimensions of land use**: agronomic potential, access to land, degree of intensity of land use, distribution of land between different uses and services provided by land. They impact the four dimensions of food and nutrition security at different scales ranging from the household to global level.

- The **variety of alternative assumptions for 2050 for the direct drivers** (urban-rural relationships, farm structures, cropping systems, livestock systems and forest systems) and **the external drivers** (global context, food diets, and climate change) of land use change, the **five scenarios and the method for building** them. Three scenarios (Metropolization, Regionalization and Households) are based on current competing trends identified in most regions of the world. Two scenarios involve potential breaks that could change the entire land use and food security system (Communities and Healthy).

- The **quantitative assessment of the scenarios** with the GlobAgri-AgT biomass balance model. Land-use changes as well as changes in domestic production and international trade of each agri-food product in each region between the initial situation and 2050 are the outputs of the model and they are used to assess the ability of each scenario to ensure world food availability: agricultural land area expansion and deforestation suggest increased tensions over land, which in turn put into question the food availability equation at the world and regional level.

- The **identification of levers and policy recommendations:** Changing the course of ongoing trends will require systemic transformation, strong and coherent public policies across sectors and scales, and consistent actions from a wide range of actors.

The healthy scenario combines ideas promoted by IAASTD

The triggering element of the Healthy scenario are the costs associated with diet-related non-communicable diseases and the consequences of malnutrition on public health. Policy measures to shift consumption patterns to healthier diets are aligned with international measures to fight climate change. Global soil improvement policies lead to the rehabilitation of degraded land for agricultural use and carbon storage. National states and urban authorities shaped more inclusive development processes linking rural to metropolitan areas, improving transport and communication infrastructures, land planning and favoring efficient food value chains.

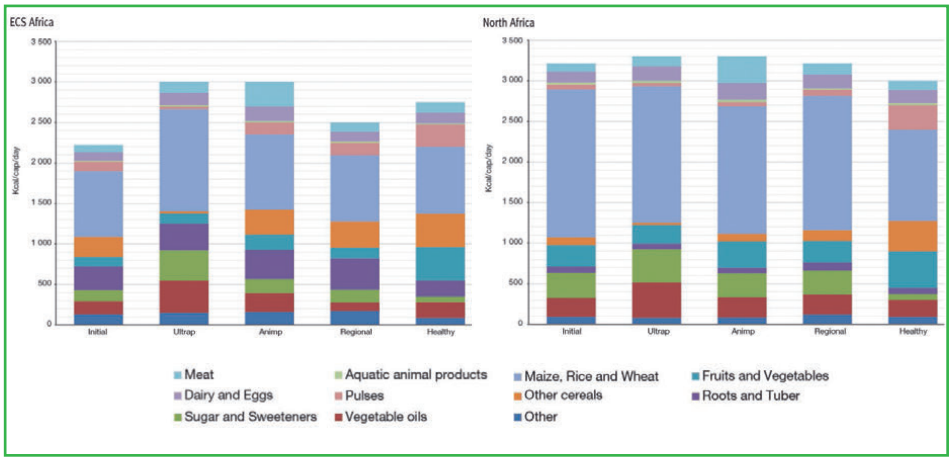
Getting healthy food requires certain types of cropping systems. These include sustainable intensification (i.e. intensification of production combined with the reduction of environmental impacts, input substitution or maximizing input efficiency thanks to new technologies) and/or agroecology. In addition, specific

types of livestock systems (i.e. agroecological livestock in synergy with agriculture and urbanization, and livestock on marginal land) and farming structures (co-operatives, and resilient farms embedded in urban processes) are key.

Nutrition and health, meat consumption

Food diets are the results of food transition patterns, in terms of the types of products consumed, food supply chains, government food policies, and health issues, notably over nutrition and undernutrition. Two assumptions on the futures of diets are based on increased consumption of animal products (Transition to diets based on ultra-processed products, and Transition to diets based on animal products with a shift from ruminant meat to poultry); in two assumptions ("Healthy diet based on food diversity", and "Regional diversity of diets and food systems"), there is a reduction in meat consumption, except in Africa and India where current level of consumption is below WHO recommendations.

Quantitative hypotheses induce very different changes in food diets from 2010 to 2050 across the regions (see figure below). In India and eastern, central and southern Africa (ECS Africa), all pathways involve an increase in the daily calorie availability per capita. As a sharp increase in population is also expected in both regions (especially in ECS Africa), this means that food consumption will increase significantly under all pathways. In addition, all pathways result in a rise in the share of animal products in diets (meat, dairy and eggs).



Food diets in 2010 (initial) and in 2050 under the different food diet pathways in various eastern, central and southern (ECS) Africa and in West Africa.[4]

Industrial agriculture and small scale farming, land grabbing, multi-functionality, women

IAASTD debunks the myth that industrial agriculture is superior to small-scale farming in economic, social and ecological terms and argues for a recognition of the pivotal role that small-scale farmers play in feeding the world population. Based on analysis of past and on-going trends, Agrimonde-Terra considers the situation is more complex, and has identified six pathways for farm structures. The first one is considered "industrial agriculture" and named "Hit-and-run agro-investments", i.e. large agro-projects raising financial funds, hiring labor and farmland, renting or grabbing land. Small and family farming can be varied. They can be: "Independent farms commercially dependent", i.e. small or large scale family farms contracting with industrial enterprises for collection, processing and marketing of standardized products; "Farms producing goods and services to surrounding communities", "Agricultural cooperatives emphasizing quality", "Resilient farms embedded in urban processes", and "Marginalized farms for livelihood survival.

For each scenario of Agrimonde-Terra, consequences of land use on ecosystem services have been appraised. Multi-functionality is one of the services provided by land in the "Communities" scenario. There is collective land management to increase the services land provides. The focus is placed on the multifunctional nature of the territory, with land contributing to the supply of biomass for energy, animal feed and materials, and foodstuffs, based on a reinforcement of biodiversity in the territory. The regulating and cultural services of the ecosystem are also enhanced. In certain regions, farmers receive payments for the non-production services they provide.

Agroforestry and farming practices that improve carbon storage and soil quality can provide healthy diets and mitigate climate change at the same time.

IAASTD and Agrimonde-Terra insist on respecting the basic rights of women, especially in rural areas in Asia and Africa. Analysis of past and on-going trends shows that the situation of women is particularly bad as far as access to land is concerned. The worrying situation of women in labor (lower salaries), in economic and social decision-making processes, etc. is underlined.

Climate, energy, agrofuels, bioenergy

Like IAASTD, Agrimonde-Terra considers that climate change is a driver of land use change. The "Healthy" scenario involves strong commitment to mitigate climate change, which requires healthy diets based on food diversity and lower meat consumption in some regions, carbon storage in soils, the production of renewable energy and the maintenance of world forest cover. There are potential tensions between the objectives of food security and climate change stabilization, because of increased competition for land between agricultural and forestry uses. Agroforestry and farming practices that contribute to improved

soil quality and the storage of organic carbon in soils (thus yield potentials) could be very interesting options in this case, since they simultaneously work towards the objectives of food security and climate change stabilization.

Agroecology and sustainable intensification

Agroecology is one of the four hypotheses for the future of cropping systems. It is essentially based on the diversification of crops (including agroforestry) and/or the coupling of crops and livestock, which most often requires a complete redesign of the production system. Yield levels will depend on the characteristics of these systems, which are highly diverse. Sustainable intensification is another type of cropping system that can lead to the Healthy scenario.

Food sovereignty, trade and markets, food speculation

In Agrimonde-Terra, the "Regionalization" scenario is based on a political and economic context of regionalization: states join in large regional blocs to face financial crises, unemployment, pollution, high rates of non-communicable diet-related diseases together; they apply a principle of "food sovereignty and subsidiarity" at the regional bloc's level based on regional food supplies, supported by businesses and civil society organizations. In this scenario, import coefficients of regions are exogenously reduced in order to figure out the inter-regional trade impact of the development of supranational regional blocks as well as the implementation of the 'food sovereignty and subsidiarity' principle.

In the future, one of the key options for public policy will be to discuss the global organization of trade due to recent important changes increased international trading of agricultural and food products, new financial actors and intermediaries, new transport routes and harbors, new norms and standards, spreading of pests and diseases, etc.

My most keenly desired policy change

I wish that policy makers, in tandem with a range of actors including. producers, consumers and civil society organizations, education and research institutions and businesses would develop a common, integral and integrating vision for their country, that fits their responsibilities in facing global challenges.

Preparing this vision would help policy-makers transcend on-going paradigms and make them consider "the future as something that we create or build, rather than as something already decided"[5]. The discussions and work necessary to develop a new vision would contribute to changing and empowering individuals as well as groups. It would also help to develop an awareness of their past and their present situation, offering a better understanding of the system and its complexity, and a clear description of what they want.

There is no given pathway to food and nutrition security while simultaneously addressing other major challenges, notably climate change, biodiversity preser-

vation and energy transition. The scope of the challenge is complex, with many overlapping and interlinked issues that cut across sectors, territories and actors; changing the course of ongoing trends requires systemic transformation, public policies and consistent action from a wide range of actors. It requires a common vision. There are a number of on-going initiatives at territorial or national levels that support this vision, policy-makers must listen to these and take them into account.

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2 de Lattre-Gasquet M, Moreau C, Elloumi M, Ben Becher L. 2017. Vers un scénario « Des usages agro-écologiques des terres pour une alimentation diversifiée et de qualité et un système alimentaire territorialisé » en Tunisie en 2050. OCL 24(3): D306.

3 See chapter 15 and de Lattre-Gasquet M. et Giordano T., 2019. Quelles perspectives pour l'agriculture et la sécurité alimentaire en Afrique subsaharienne en 2050? Réalités Industrielles, août 2019, p. 50-56.

4 Source: Le Mouël et al., 2018, Figure A2.1, p.387-388

5 de Jouvenel H., 2004. *An invitation to foresight.* Futuribles, Paris, 90 p.

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Frédéric Lançon

Urbanization and the effects on agriculture and food security

Historically, urbanization has been associated with the consumption side of the food system, while rural areas have been viewed as the suppliers of food products. Urban and rural areas have also traditionally been seen as competitors for the allocation of human resources (labour) and natural resources (land, water).

In terms of food security, this spatial dichotomy was emphasized by a rapid growth of the urban population in low-income countries, particularly in Sub-Saharan regions. This generated a recurrent food dependency of low-income countries on the international food trade. The globalization process of the food systems during the late nineties and early two thousands, including the upgrading and expansion of global food value chains ("the supermarket revolution") can be seen as the materialization of this food dependency. The 2008 food price surge demonstrated the inherent social and political risks "(i.e. hunger riots") of food market globalization, which in turn triggered the need for a change of the "globalization narrative" and the food policy agenda.

The formulation of a new narrative to understand how urbanization processes interplay with food security requires us to critically review the conventional analytical 'rural area versus city' framework in relation to how food systems function.

In low-income food deficit countries, only 33% of the population is urban.

Deeper analysis suggest that food systems are not structured along a supposed rural-urban divide, but on the contrary include interactions that are far more complex. Urban diets include a wide range of imported and locally produced food and meals, often consumed outside the home for convenience. The share of imported food in urban consumer's diets is not necessarily determined by income level. Poor consumers can purchase imported or industrial processed food, while better off urbanites can also consume traditional dishes made from local product.

In relation to the urbanization process, at the global scale, since 2006 more than 50 % of the world's population now live in urban areas, however this percentage remains lower in poorer countries. For instance, in low-income food deficit countries, only 33% of the population is urban, underlining the point that the urbanization rate is not the only determinant of food dependency. It also shows

that the urban transition is far from complete in poorer countries and that the pressure from urban food demand on both rural supply and import will further expand in the coming decade.

Regarding competition between rural and urban areas for labour, it should also be emphasized that migration is no longer the major driver of the urbanization process. Urbanization is mostly fueled by natural urban population growth (i.e. most urbanites are born in cities). Conversely, rural-urban migration does not lead to a decline of rural populations; in sub-Saharan Africa, rural populations will continue to increase until the middle of the century.

On average 50% of staples consumed in rural areas in West Africa are purchased.

An on-going rural population increase will result in both higher requirements in rural employment (which can be generated by food production), and in additional food demands within these rural areas. Another counterintuitive dimension of the food system in a rural-urban perspective is that a high share of rural food consumption is purchased from food markets and not produced and consumed within the household. In West Africa Expenditure and Consumption surveys indicate that on average 50% of staples (cereals and tubers) consumed in rural areas are purchased, the share is even higher for meat products (75%).

Urban food supply combines a number of food chains that source food either from imports or from the rural hinterland. While imported food chains are often governed by large scale corporations using formal retailing networks (supermarkets), local food chains rely on smaller scale trading and labor-intensive processing entities that are often informal. Small scale informal trade and food street vendors play a key role in mitigating "food deserts" in fast growing marginal and poor urban areas where formal food retailing networks are absent. This ensures better access to the food supply for vulnerable populations.

Local food chains play a strategic role in linking rural areas to urban consumers, ensuring job opportunities along the whole chain. The densification of rural areas support the emergence of secondary urban centers which also, in turn, play a critical role in the organization of the local food chain hubs through the provision of services to traders and processors.

At the global level, the urbanization process is clearly marked by the increasing share of large cities; in 1950 60% of the urban population were living in cities with less than 300 000 inhabitants, in 2020 this share declined to 40%, while 13% of urbanites are now living in megapolis of more than 10 million inhabitants. However, in low income countries, the urban population living in smaller cities still represent 50 % of the total urban population. In Sub-Saharan Africa in 2000, 100 million urbanites lived in cities with less than 300 000 habitants, by 2020 this figure had increased to 218 million. Food chain intermediaries, often based

in these smaller urban centres, contribute to the transformation of agriculture through investment in production (investment in land, technical innovation) in order to adapt their food sourcing to their client requirements.

In conclusion, urbanization processes are not a constraint for strengthening food security but rather a source of agricultural transformation and dynamism that support food production.

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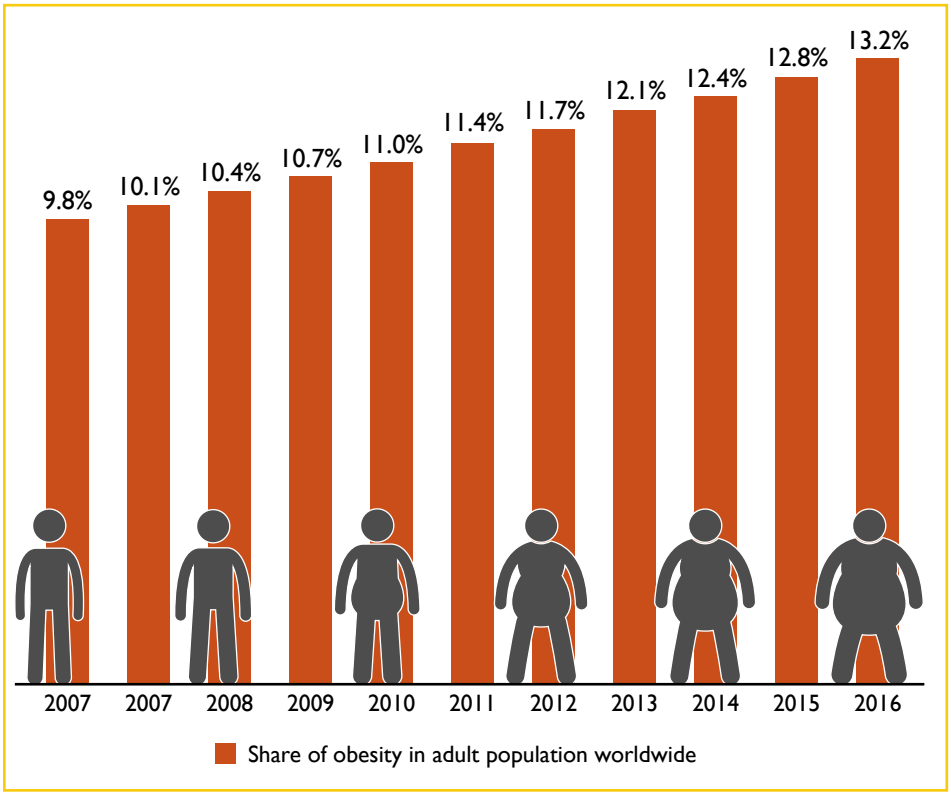
10-Year Comparison

Obesity



Prevalence of obesity among adults (both sexes) worldwide in per cent. According to the WHO definition, a person with a Body Mass Index (BMI) greater than or equal to 30 is considered obese. BMI is calculated by weight in kilograms divided by height in metres squared.

Overflowing plates and growing bellies – an escalating crisis

In 2016, more than 1.9 billion adults or 39% of all people aged 18 years and older were classified as overweight, 650 million of whom were obese. The worldwide prevalence of obesity nearly tripled between 1975 and 2016. Among the main causes of excess weight are the increasing intake of foods high in saturated fats, salt and sugar coupled with lack of physical activity. Being overweight and obese was once considered a problem of high-income countries, but rates are now also on the rise in low- and middle-income countries. It is common to find undernutrition and obesity co-existing within the same country, the same community or even the same household. And the outlook for the next generation of adults is bleak: Over 340 million children and adolescents aged 5-19 were overweight or obese in 2016. The prevalence of the overweight and obese in this age group has risen dramatically from 4% in 1975 to over 18% in 2016.

Sources

1 WHO World Health Organisation (2017). Global Health Observatory data repository: Prevalence of obesity among adults, BMI ≥30, crude. Estimates by WHO region. https://apps.who.int/gho/data/view.main.BMI30CREGv?lang=en
2 WHO World Health Organisation (2020). Obesity and overweight: Key facts. Updated 3 March 2020. https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight

Anita Idel

The vast potential of sustainable grazing

Next to forest, grassland is the largest biome on our planet, covering about 40 % of vegetated land surface. Of all agricultural land worldwide, one third is cropland and two thirds are grassland. Richard Conant from Colorado State University emphasizes in a Technical Report for the FAO the soil fertility of steppe grassland: "Good grassland management can potentially reverse historical soil carbon losses and sequester substantial amounts of carbon in soils." According to global estimates by the FAO, grassland soil stores 50 % more carbon than forest soil (Conant 2010; Dass et al 2018).

This is because grassland has a different growth dynamic compared to forests. Trees store most of the absorbed carbon in their own biomass, mostly in the wood above ground. What we see above ground is the result of many years and even centuries. Grasses, however, store most of the absorbed carbon not in their own biomass. Due to the co-evolution of million years, grasses need the bite as growing impulse (what we can imitate by mowing). What we see above ground is only the result of a few months of growth, at most. Grasses store most of the absorbed carbon in the soil as the dominating part of soil organic matter (humus). As 1 tonne of humus contains more than 50 percent carbon, it relieves the atmosphere of about 1,8 tonnes CO_2 (Idel 2020).[1]

Globally, grazing is as important for non-arable land as it is for the world's extremely fertile bread baskets: "Savanna, steppe, prairie, or pampas: They're all grasslands, the globe's most agriculturally useful habitats" (Nunez 2020).

According to global estimates, grassland soil stores 50 % more carbon than forest soil worldwide.

Discussing soil fertility, most scientists are not aware of the common origin of these areas: The extremely fertile (former) grass plains on our planet with black chernozem soils are steppes which developed through the co-evolution of grasses and grazing animals. Grazing induces a growing impulse in grasses. These possess huge amounts of fine roots and a root-shoot-ratio from 2-20 to 1. That's why the resulting carbon storage is mostly root-derived (Bakker et al. 2013). The roots of today are the soil organic matter of tomorrow.

The black soils of the North American prairies, the Ukraine grasslands, the Hungarian Puszta, the Baragan Steppe in Romania as well as those in Kazakhstan, Mongolia and China (Manchuria) or the subtropical Pampas in Argentina and Uruguay not only all have high fertility, but also have the same origin by grazing. A high share of mineral loess loam was a good precondition for the develop-

ment of soil organic matter, but it became stimulated from above – through grazing.

Grassland provides the livelihood for one tenth of the world's population. The FAO estimates, that for 100 million people in dry regions and probably another 100 million people in other regions, grazing animals are the only available income source (FAO 2020). "Mobile pastoralists (…) may also offer one of the greatest hopes for mitigating climate change" (Davis and Nori 2008).

The ecological potential of grazing animals found little reflection in the IAASTD reports.

The IAASTD process recognised the world's mobile and semi-mobile pastoralists as important groups among indigenous societies – but mainly for socioeconomic reasons, because their grazing animals are key to satisfying their basic needs. Unfortunately, the ecological potential of pastoralists and their grazing animals has been and still is massively underrated and found little reflection in the IAASTD reports.

There are three main reasons why the vast potential of grazing is often overlooked:

1. Grazing is perceived as extremely negative where it is associated with **rainforest destruction** for industrialised beef production. While this is indeed an abuse of rainforests and the least fitting area for grazing, it would be a dangerous mistake to condemn grazing generally.

2. In the last decades **overgrazing** became dramatically widespread in different regions of the world for three reasons: increasing herd sizes, decreasing availability of land and politically warranted restriction of mobile grazing by incentivising nomadic people to settle. Starting during colonial times and later continued by means of developmental aid, millions of dollars were spent on wells as cattle dew points. As a result, herds remain in one location for much longer than the grassland can support (FAO 2020).

3. Cattle are perceived as climate killers because of their immanent burping of **methane** (ructus). But there is a huge difference between industrial livestock farming on the one hand and cattle grazing on carbon storing steppe soils and non-arable land on the other hand. Industrial livestock farming causes additional climate and other environmental impact through the feed production, which is often based on land use change – ploughing up grasslands and cutting down rainforests – and on pesticides and synthetic nitrogen fertilizer. This in turn releases nitrous oxide (N_2O) which has 300 times the climate impact of CO_2 – costs which are fully externalized (Idel and Reichert 2013).

Sustainable cattle grazing on permanent grassland does not compete with other uses and therefore does not happen at the expense of human food production.

Furthermore, it is key regarding groundwater regeneration – quantitatively because of grassland's large share in vegetative cover of soils worldwide and qualitatively because of its low(er) level of pollution with pesticides and synthetic fertilizer. An additional benefit of sustainable grazing is hidden in the excrements: One cattle of about 500 kg is producing some 10 tonnes of dung per year, which in turn supports the biomass of more than 100 tonnes of insects per year – fodder needed for biological food chains and biodiversity (Idel 2020).

Endnote

1 Carbon has a molecular weight of 12g/mol, while CO_2 has a molecular weight of 44g/mol (due to the addition of two oxygen molecules). Hence 1 kg of carbon, if oxidized, will release 3.67 kg of CO_2.

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Boyd Swinburn

The agriculture and health nexus: a decade of paradigm progress but patchy policy actions

In 2019, the Lancet Commission on Obesity published the report "The Global Syndemic of Obesity, Undernutrition and Climate Change".[1] It highlights multiple opportunities for systemic actions aimed at the underlying drivers of obesity, undernutrition and climate change. Many of the potential systemic actions to address the Global Syndemic directly apply to agriculture and their origins can be found in earlier reports such as the 2009 Agriculture at the Crossroads report.

What an enlightening exercise it is to pause and reflect on the evolution of a massively important issue over 10 years. The 2009 Agriculture at the Crossroads report[2] from the International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD) was a formidable piece of scholarship backed by an extensive global consultation process. It clearly helped to pave the way for new thinking, new trans-disciplinary connections, and new high-level directions for agriculture. The eight themes identified in the report articulated the reach of agriculture's octopus tentacles: bioenergy, biotechnology, climate change, human health, natural resource management, traditional knowledge and gender equity. I will focus mainly on the health and food system links. Having examined these for the 2019 Lancet Commission on Obesity, which I co-chaired, we concluded that the nutrition problems of obesity and undernutrition needed to be seen together with climate change as one entity which we called The Global Syndemic. My overarching sense is that in the past decade we have made considerable strides at the levels of paradigms, concepts, rhetoric, and global commitments but the policy action on the ground has remained patchy and sluggish – far too sluggish for the urgency that the food systems crisis demands.

Think of the global responses to other crises. In 2007-2008, the global financial crisis galvanised world leaders into pouring trillions of dollars into rescue packages,

including bailouts of the private financial institutions who created the crisis in the first place. The 2019-2020 Covid-19 pandemic, galvanised governments and international organizations into creating a coordinated lock down of cities and people movement based on precautionary and preventive principles. The world can collectively implement drastic actions if the threat is acute and the fear level is high.

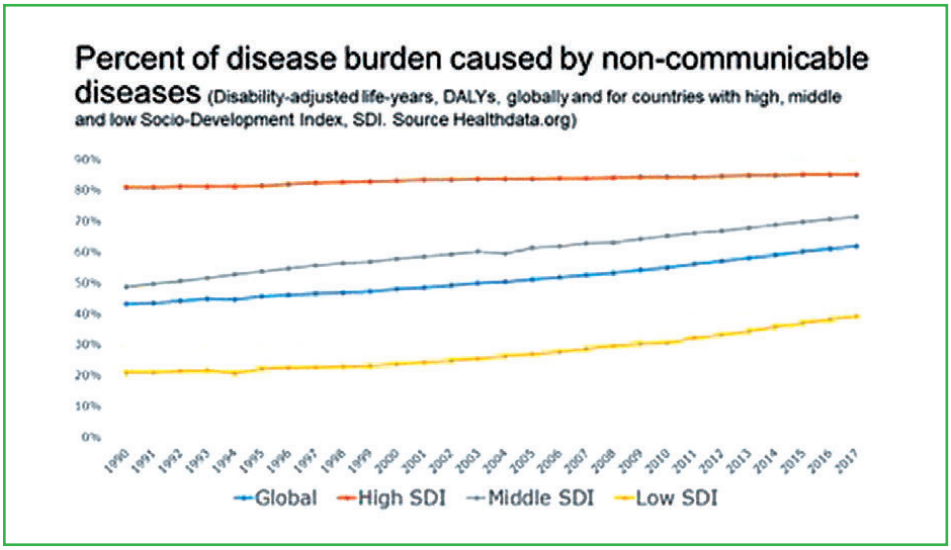
The food system crisis is slower (decades rather than months) and the fear level is relatively low. This is despite the inexorable rise in obesity in all countries, the inadequate progress in reducing undernutrition in many African and South-East Asian countries, and the existential threats of climate change and environmental damage that our food systems are helping to drive. What has been the political response to the food system crisis? Where is the coordinated rallying of government responses? Where is the sense of threat and urgency? Where are the headlines?

We have made considerable strides at the levels of paradigms but the policy action on the ground has remained sluggish.

A clue to the weak responses to the food system crisis can be found in the opening pages of the IAASTD report. In the Statement by Governments section, three countries, Australia, Canada and the United States of America, did not approve the final report. They undoubtedly also used their political clout throughout the process to water the report down as much as possible to minimise its impact on business as usual. Business as usual, of course, is that large agricultural sectors in the rich countries use their considerable lobby power over their governments to maintain agricultural policies and subsidies in their commercial favour.

The politics in the last decade have not changed enough amongst the rich countries to support the implementation of the excellent actions proposed in the IAASTD report. In fact, the food industry's market power has become even more concentrated into fewer mega-corporations and their lobbying expertise has become even more sophisticated. At the international level, the US political forces driving their own national and commercial agendas remain a huge barrier to achieving the collective international action needed to address the food systems crisis.

Interestingly, the IAASTD report started with a push from private sector and the World Bank around biotechnology and specifically transgenics. However, the highly-consultative process undertaken with a wider group of stakeholders expanded the agenda to include reducing hunger and supporting sustainable development. This agenda setting occurred in the era of the Millennium Development Goals (MDGs), which did not include non-communicable diseases (NCDs), acknowledged at the time to cause 60% of all deaths, 80% of which were in low and middle income countries (LMICs)[3]. The figure shows how NCDs have risen as a proportion of total disease burden for all countries but especially in LMICs (shown as low and middle Socio-Development Index).



Undernutrition was centre stage and obesity was not even considered in the MDGs. We are now in the era of the Sustainable Development Goals (SDGs) which gives due prominence to the world's dominant health problems of NCDs and wraps undernutrition and obesity together into 'malnutrition in all its forms'. This is great progress towards the holism needed for collective action.

The IAASTD report placed itself clearly in the technical space (agricultural knowledge, science, and technology). We have learnt over the past decade that the technical barriers are far less important and more easily fixed than the political and commercial barriers. Major reports from the UN and international agreements now pay more attention to implementation issues and monitoring and reporting systems for accountability. More attention is also paid to managing conflicts of interest, although this is still far from ideal and commercial vested interests are still very dominant in the development of national food policies and subsidies.

The inclusion of a theme in the IAASTD report on traditional and local knowledge and community-based innovations was very insightful. These other worldviews and bodies of knowledge have much to offer, especially at the local level, but they are consistently undervalued in the search for mega-answers or technology fixes.

If a modern day IAASTD report were to be written, it would undoubtedly update and highlight some of these themes and paradigms that have achieved prominence in the past decade. It might include a focus on the perpetrators (extractive commercial operators who create negative externalities, and corrupt or inept governments who do little about it) as well as the victims (small farmers, children, women, and people living in poverty). It might focus more on in-

equities and the neoliberal economic policies that are creating them. It might be more cautious about public-private partnerships with those industries that are party to the problem. It might highlight even more the systemic view of food and agricultural systems and explicitly champion the shift from considering food as an economic commodity to increase GDP, export earnings, and company profits to food as a common good for human health, ecological health, social equity and economic prosperity for all.

The 2009 IAASTD report was a forerunner of many subsequent reports that bring together the silos of agriculture, health, climate, social equity, and economics. The 2019 Lancet Commission on Obesity report on the Global Syndemic of obesity, undernutrition and climate change was one such report. I had both hopes and fears about joining up three major, unsolved global problems into a single conceptual entity. My hope was that it would allow people see beyond the visible manifestations of obesity, undernutrition and climate change into their common underlying drivers in the food systems, transport systems, land use and urban design. My fear was that it would further heighten people's 'complexity confusion' and disillusionments about getting meaningful action. It turned out my hopes triumphed over my fears. Once it is pointed out, people really see the connectedness between problems, understand the commonalities of their drivers and look for double- or triple-duty actions.

One major paradigm shift in the last decade has been the NOVA classification of foods based on their level of processing.

In 2013, FAO and WHO had a joint meeting called 'Meeting of the minds' which brought health and agriculture together around the table on the theme of 'nutrition-sensitive agricultural policies.' It was surprising to me how far apart the minds were at that meeting – it seemed like health was trying to impose its agenda on a reluctant agriculture which was in turn defending its existing priorities. In retrospect, this jostling about the purposes of agriculture was probably just the process of two huge silos getting to know and trust each other. Since then, the narrative and collaboration has moved much more onto a common agenda of collective food system approaches to the crises of climate change and malnutrition in all its forms. While that narrative has good high-level traction, the power politics still play out on the ground and policy actions on food systems, while heading in the right direction, remain painfully slow. The national legal and economic measures countries are adopting to achieve carbon neutrality tend to leave out agriculture or delay its inclusion. This is partly because of the complexity of accounting for agricultural emissions of methane and nitrous oxide within carbon budgets but it is also because of the lobby power of the agricultural sector and the challenges of creating just transitions for the farmers whose livelihoods are affected.

One major paradigm shift in the last decade has been the NOVA classification of foods based on their level of processing rather than nutrient composition.[4] The categories of unprocessed or minimally processed foods, processed culinary

ingredients (like flour, oil and salt) or processed foods (like cheese and bread which can be made domestically) are not closely associated with health problems. However, the foods defined as ultra-processed food are industrial formulations of multiple food constituents and additives and contain little if any whole foods. It is this group of hyperpalatable foods which tends to contain high levels of salt, sugar and fat and a high consumption of them is related to nutritional health damage – mainly for obesity and NCDs. These foods also exacerbate undernutrition with empty calorie foods, like instant noodles, sugary drinks and processed snacks, displacing more nutritious food. Vast agricultural lands and subsidies are dedicated to the raw materials for ultra-processed foods such as wheat, sugar and corn. The IAASTD report pointed to this problem but in the intervening decade, considerable evidence has accumulated implicating these ultra-processed food products as core drivers of obesity and NCDs.

The options laid out in the IAASTD report for addressing the nutritional burden of NCDs reads like all the subsequent reports on the issue: food systems directed towards quality and diversity of foods rather than quantity and price; multi-sectoral policy responses with a strong emphasis on regulation rather than a reliance on education and individual behavioural change; fiscal measures, such as taxes and subsidies, that align with health; monitoring systems for accountability, and; international agreements on labelling and marketing practices.

Overcoming Policy Inertia

Policy Inertia is the phenomenon of the lack of policy action in the face of a major problem with widely-agreed, well-defined, evidence-based actions for implementation. According to the Global Syndemic report, the three major contributors to Policy Inertia are: 1) Industry opposition to the actions; 2) government unwillingness to tax and regulate (related to 1), and; 3) lack of demand from civil society for policy action.[3] What will be the disruptive force to break this impasse? I see civil society as the 'sleeping giant', which, if aroused, could be the game changer. Civil society actors (NGOs, academics, professional organizations, and the public) typically have passion and commitment by the bucketload but they also have diverse agendas, are poorly coordinated, and lack money. Bloomberg Philanthropies have shown in several countries that an injection of funding for communications, coordination, evaluation and social lobbying can catalyse social changes and generate sufficient demand for action that effective food policies are implemented despite industry opposition and government reluctance. If this general model could be widely applied in various forms in different countries, then we might start seeing the global movement needed to overcome the Policy Inertia that is killing us and our planet. That is my hope and current mission.

The need for a broad approach to food safety is evident in the IAASTD report and this has been underlined by recent events: the probable cancer-causing properties of the commonly used herbicide glyphosate; the threat to fruit and vegetable production from pesticide-induced declines in pollinator populations, and the emerging novel infectious diseases, such as coronavirus, arising from agriculture and food systems. The strong regulatory approach applied to standard food safety practices, such as food handling and storage requirements to prevent foodborne infectious diseases, could be expanded with definitions of food safety which encompass longer-term, population-wide or ecosystem threats from food.

Sustainable, food-based solutions to undernutrition were promoted in the IAASTD report, but this approach seemed to play second fiddle to education strategies and technology solutions, such as biofortification. The shift in thinking over the last decade from programmatic approaches to systemic approaches for nutrition problems is welcome. However, describing nutrition problems and solutions in terms of complex, adaptive systems is a real communications challenge. Governments and non-government funders are much more supportive of scalable feeding or fortification or education programs to patch up the visible problems of starving children and mothers than they are of programs for obesity and diabetes. Indeed only 2.2% of development aid for health is allocated to NCDs, despite NCDs being responsible for two thirds of deaths in LMICs, half of which occur under the age of 60.[3] Funders are also reluctant to shift from the direct funding of less effective education and programmatic responses to funding advocacy for the more effective regulatory and fiscal responses because these involve protracted battles against vested commercial interests.

The strong regulatory approach applied to food safety could be expanded to longer-term, population-wide threats from food.

In the Global Syndemic report, we highlighted multiple opportunities for systemic actions aimed at the underlying drivers of obesity, undernutrition and climate change. Double or triple-duty actions are those that have multiple impacts across the Syndemic with examples being the development of sustainable, healthy dietary guidelines, labelling food with both health and environmental footprint signposts, or restricting the lobbying power of commercial entities on food policy development.[5]

Many of the potential systemic actions to address the Global Syndemic directly apply to agriculture. The most powerful lever for re-orienting any system is to change its underlying purpose and values.[6] For agriculture, the paradigm shift from extractive to restorative agriculture is underway at a high level and in pockets locally. To make a difference globally, this nascent movement will need to reach inside millions of farm gates around the world where small farmers, in particular, are struggling to maintain a livelihood. National policy statements about agriculture as a positive force for human health, ecological health, and social equity as well as economic prosperity would set the directions for policy, regulatory and economic levers to be applied to achieve this outcome.

Boyd Swinburn

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Marie Josèphe Amiot

Food systems in relation to nutrition and health

One in three people worldwide is affected by one or more forms of malnutrition (FAO et al. 2018). After a prolonged decline, the number of undernourished people increased to 821 million in 2017, adults overweight or obese reached 1.9 billion, and approximately two billion people worldwide were classed anemic and suffering from micronutrient deficiencies. A lack of essential vitamins and minerals often result in "hidden hunger" where signs of undernutrition and hunger are less visible. A person may have access to sufficient calories but lack adequate micronutrients, vitamins and minerals. "Hidden hunger" has deleterious consequences on health (Micronutrient Initiative, 2010). The triple burden of nutrition (i.e. macronutrient deficiency, deficiency in micronutrients and excess weight) can coexist within a same country. The main drivers of malnutrition include a failing food system, leading to poor nutrition, inequality, migration and conflict.

A big challenge is child malnutrition. Child stunting and wasting affect 151 million and 51 million children respectively. The causes of stunting in children are mainly due to inadequate diet and hygiene during pregnancy and the first 2 years of life (also known as the "1,000 days"). Maternal undernutrition generally results in fetal undergrowth and underweight child at birth. Inadequate breastfeeding and inappropriate non-affordable formula milk or complementary food are major factors that contribute to malnutrition in children. A recent report suggests that only 2 in 5 children meet minimum meal frequency.

The valorization of cultivated biodiversity and neglected nutritious species would sustain healthier diets.

Adult malnutrition is multifaceted and one of the causes is the consumption of energy-dense foods rather than nutrient-dense ones. This is also characterized as 'nutrition transition' that has resulted in substantial increases in the intake of sugar, salt and saturated fats, at the expense of a reduced consumption of whole grains, pulses, vegetables and fruits. In countries across the South, dietary diversity is positively associated with nutritional adequacy (coverage of nutritional needs); however, people living in urban environment are nowadays consuming more 'western'-type food that are energy-dense, with limited dietary diversity, rather than their traditional local foods.

The broad approach to reduce all three forms of malnutrition must be based on the promotion of healthy, diversified and sustainable diets. Sustainable diets

are protective and respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair and affordable, nutritionally adequate, safe and healthy, while optimizing natural and human resources (Burlingame & Dernini, 2010). In the 2030 Agenda for Sustainable Development, nutrition is spread in the numerous Sustainable Development Goals (SDGs 1, 2, 3, 5, 8, 10, 12, 14, 17). Moreover, the proclamation of the United Nations Decade of Action on Nutrition in April 2016 provides a unique opportunity for stakeholders to strengthen joint efforts towards eradicating hunger and preventing all forms of malnutrition worldwide.

In the context of climate change, growing populations and urbanization, nutrition and food production are interconnected and all the dimensions of food security and nutrition (including food availability, access, utilization and stability) are likely to be affected. There is a consensus agriculture, environment, food and health should be reconnected (Lamine et al. 2019; IPCC, 2019). A consumption-oriented approach based on all the dietary needs has been proposed that complements a production-oriented approach, usually restricted to macronutrient supply (Verger et al. 2018). Nutrition must be introduced into all the policies at macro (national), meso (territories) and micro (households/ individuals) levels that allow changing the whole food system towards more sustainability.

Measures to ensure food and nutritional security and sustainable development

National policies can support a healthy supply of processed foods and beverages, targeting a reduction of sugar, salt and saturated fat quantities.. Food reformulation help consumers eat healthily and sustainably. Dietary guidelines and packaged food labelling policies are key to guide consumers to healthier food choices.

Biodiversity can contribute to food security and improved nutrition. The valorization of cultivated biodiversity and neglected or underutilized nutritious species, such as leafy edible plants, would be a means to sustain food systems and healthier diets (Hunter et al. 2019).

Territorial approaches can be used to implement agri-food policies that better fit with a local context for greater sustainability, including nutritional objectives. Territorial Food Projects, as developed in France, aim to provide a strategic and operational framework for partnership actions responding to social, environmental, economic and health needs.

Locally-driven development of short accessible and affordable nutrient-rich food chains like fruit and vegetables must be tailored to allow delivering key nutritional requirements and helping to prevent non-communicable diseases.

Food waste and food loss lead to the discarding of huge amounts of nutrients and there is therefore a need to reduce them by investing in technology, practices and new norms to avoid spoiling the most perishable foods along the chain.

Communication strategies must be implemented to educate consumers about the benefit of a diversified diet based on healthier foods. School meals can also help shape children preferences and attitudes towards healthy foods and eating habits.

In terms of impact, there is a need to collect more data to explore national, territorial and consumer group interventions on nutritional outcomes and sustainability indicators. In addition to quantitative change assessments of consumption and production that meet all nutrient needs without harming the environment, a qualitative approach allows us to understand the levers and obstacles that ensure sustainable food and nutritional security. Both approaches inform decision-makers to fully support sustainable food systems.

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Alexander Wezel

Agroecological approaches and other innovations

In June 2019, the HLPE report on "Agroecological approaches and other innovations for sustainable agriculture and food systems that enhance food security and nutrition"[1] was released. This report is the first FAO report dealing prominently with agroecology. It suggests a concise set of 13 agroecological principles and points out that there has been much less investment in research on agroecological approaches than on other innovative approaches.

The High Level Panel of Experts for Food Security and Nutrition (HLPE) is the global level science-policy interface of the Committee on World Food Security (CFS) and the foremost evidence-based, inclusive, international and intergovernmental platform for food security and nutrition (FSN). The HLPE provides a comprehensive overview of the topics selected by the CFS, based on the best available scientific evidence and considers different forms of knowledge. HLPE strives to clarify contradictory information and knowledge, to elicit the backgrounds and rationales of controversies, and to identify emerging issues.

The HLPE (2019) report is based on extensive research about the current situation of agriculture and food systems, describes the fundamentals and principles of agroecology, and details to what degree agroecological approaches can provide solutions for future challenges. The report also provides a comparison between different criteria for agroecological and related approaches (including organic agriculture, agroforestry and permaculture) and sustainable intensification approaches (including climate-smart agriculture, nutrition-sensitive agriculture and sustainable food value chains). The report also presents controversial debates about how to reach food security. These include the deployment of biotechnology and digital technology, the use of synthetic fertilizer, conservation of biodiversity in agricultural landscapes, need of size of agricultural enterprises, and if agroecology can feed the world. In this essay the contents, findings and several recommendations of the report are presented.

Agroecology is a dynamic concept that has gained prominence in scientific, agricultural and political discourse in recent years. It is increasingly promoted as being able to contribute to transforming food systems by applying ecological principles to agriculture. These principles allow for the regenerative use of natural resources and ecosystem services while also addressing the need for socially equitable food systems within which people can exercise choice over what they eat and how and where it is produced. Agroecology embraces a science, a set of practices and a social movement and has evolved over recent decades to expand in scope from a focus on fields and farms to encompass whole agriculture and food systems.

Agroecology is a transdisciplinary science, combining different scientific disciplines to seek solutions to real world problems. It works in partnership with multiple stakeholders, considering local knowledge and cultural values in a reflective and iterative way that fosters co-learning among researchers and practitioners. Agroecology also allows for the horizontal spread of knowledge from farmer to farmer or among other actors along the food chain. Initially the science of agroecology was focused on understanding field-level farming practices that use few external inputs but high agrobiodiversity, emphasizing recycling and maintenance of soil and animal health, including managing interactions among components and economic diversification. The focus has since expanded to include landscape-scale processes, encompassing landscape ecology and, more recently, social science and political ecology related to the development of equitable and sustainable food systems.

Agroecology encompasses a science, a set of practices and a social movement.

Agroecological practices harness, maintain and enhance biological and ecological processes in agricultural production in order to both reduce the use of purchased inputs that include fossil fuels and agrochemicals and to create more diverse, resilient and productive agroecosystems. These practices include, for example, diversification in rotations and production; intercropping; cultivar mixtures; habitat management techniques for crop-associated biodiversity; biological pest control; improvement of soil structure and health; biological nitrogen fixation; and recycling of nutrients, energy and waste. There is no definitive set of practices that could be labelled as agroecological. But agricultural practices can be classified along a spectrum and qualified as more or less agroecological, depending on the extent to which agroecological principles are locally applied. In practice this comes down to the extent to which: (i) they rely on ecological processes as opposed to purchased inputs; (ii) they are equitable, environmentally friendly, locally adapted and controlled; and (iii) they adopt a systems approach embracing management of the interactions among components rather than focusing only on specific technologies.

Social movements associated with agroecology have often come about in response to agrarian crises and operated in tandem with broader efforts to initiate

widespread change to agriculture and food systems. Agroecology has become the overarching political framework under which many social movements and peasant organizations around the world assert their collective rights and advocate for a diversity of locally adapted agriculture and food systems mainly practised by small-scale food producers. Social movements highlight the need for a strong connection to be made between agroecology, the right to food and food sovereignty, positioning agroecology as a political struggle, which requires people to challenge and transform the structures of power in society.

The report suggests a set of 13 agroecological principles: recycling; reducing the use of inputs; soil health; animal health and welfare; biodiversity; synergy; economic diversification; co-creation of knowledge; social values and diets; fairness; connectivity; land and natural resource governance; and participation.

In current debates on how sustainable food systems can be developed and food security be reached, based on agroecological approaches, three critical issues are in the forefront:

(i) How much food needs to be produced to achieve FSN (food security and nutrition); centred on whether FSN is mainly a problem of availability or more an issue of access and utilization?
(ii) Could agroecological farming systems produce enough food to meet global demand for food?
(iii) How to measure the performance of food systems, taking into account the many environmental and social externalities that have often been neglected in past assessments of agriculture and food systems?

In relation to i) the report indicates that, in respect of food production, a larger number of people could be fed, but that access to food is not sufficiently guaranteed, that losses are too high in food storage and processing, that changes in animal production and consumer diet (in particular related to meat consumption) would be necessary, that food resources should not be used for biofuel production, and that current policies do not sufficiently support smallholders, which produce 70% of the world's food.

In respect of ii) the answer of many agriculture experts is yes, however contrasting opinions exist amongst other experts, who see conventional agriculture with innovation and biotechnology as more suitable. For both proponents it is valid that the points under i) need to be considered. Here it has to be stated that conventional agriculture in its present form has hitherto not been able to provide sufficient food and FSN. For FSN in developing countries, the report provides different examples - whereby agroecological approaches and practices can positively influence a variety of factors. For example, increased food provision of families in critical phases during the year with food availability shortage, or improved nutrition of small children. Other examples show that increased

diversification in plant production enhanced diversity of diets, and with this different health factors also improved. The diversification in production also increased resilience to climate change impacts. Moreover, positive influences on the economic situation of households can be stated as well as for women empowerment.

In relation to iii), measurement and assessment factors such as ecological footprints and agency need to be taken into account. Agency refers to the capacity of individuals or communities to define their desired food systems and nutritional outcomes, and to take action and make strategic life choices in securing them.

To overcome the challenges, different innovations are required. Conventional views of innovation in agriculture have often focused on the introduction and spread of adoption of new technologies. Recently, greater emphasis has been placed on promoting: (i) inclusive and participatory forms of innovation governance; (ii) information and knowledge co-production and sharing among communities and networks; and (iii) responsible innovation that steers innovation towards social issues.

One example of a highly controversial issue is biotechnology. The report outlines a polarised debate centred on public concerns about safety, environmental impacts, concentration of power within food systems and the ethics of gene modification. Proponents of agroecology see different aspects of modern biotechnology in conflict with core agroecological principles – these are often associated with ecology, democratic governance and sociocultural diversity. Recent calls for a global observatory for gene editing propose increased scrutiny, dialogue and deliberation on the use of biotechnologies. On a global scale, modern biotechnologies are a significant component of the agricultural systems of a number of countries. In contrast, in agri-food systems where input-intensive models have not been adopted, solutions may be found that do not rely on the adoption of biotechnologies used elsewhere.

Diversification in production also increases resilience to climate change.

The report provides different recommendations to governments and policy makers. Among these recommendations are the use of relevant performance metrics for food systems that consider all environmental, social and economic impacts of food production and consumption. In particular, the ecological footprint of different food systems needs to be enhanced. States and governments should support diversified and resilient production systems, including mixed livestock, fish, cropping and agroforestry that preserve and enhance both biodiversity as well as the natural resource base. This should be done by i) redirecting subsidies and incentives that at present benefit unsustainable practices, ii) supporting use of participatory and inclusive territorial management planning and management, iii) building adaptation of in-

The HLPE report is the first FAO report or publication to deal prominently with agroecology. The acceptance of agroecology as one of the pathways and alternatives to develop sustainable agriculture and food systems in the policy arena officially started in 2014, when FAO organized a first International Symposium on Agroecology for Food Security and Nutrition, followed later by 7 regional meetings from 2015 to 2017 in Latin America, Africa, Asia and Europe. A second International Symposium was convened by FAO in 2018 on scaling up agroecology to achieve the Sustainable Development Goals. Here former FAO Director-General José Graziano da Silva called for healthier and more sustainable food systems – stating that agroecology can contribute to such a transformation, and that in addition, it offers multiple benefits, including increasing food security and resilience. This opened up the way or the scaling up of the agroecology initiative of FAO, for the HLPE report, and policy debates.

Although the HLPE report can be seen as an important step forward, the outcomes and recommendations could have been more specific and progressive. It is clear that some messages and recommendations have been diluted for political reasons and to accommodate commonly agreed views and positions of stakeholders in the CFS to not put too much emphasis on agroecology as a solution to change current agriculture and food systems. For example, the wording "agroecological approaches and other innovations" often appear with critical and controversial points in order to not indicate a necessary pathway, solution or recommendation to change present systems and policies. However it should be noted that the expert authors made clear requests as to where and where not to place agroecology in their final draft. But overall this report demonstrates clearly that the potential and contribution of agroecology for the development of sustainable agriculture and food systems, the need for a paradigm change and new policies to support alternative systems can no longer be ignored by policy makers, governments or agribusiness sector stakeholders.

Overall, the most important and urgent policy change that is necessary is a shift from the yield maximising paradigm that ignores its associated negative environmental and social externalities. Policies should support farmers and production systems that make the best use of natural resources, harness ecosystem services and ecological processes sustainably, and are not harmful to environmental and human health. Policies should also be harnessed to counteract concentrations of power in supply chains and agri-food businesses that are a barrier of change and hinder a transition towards more sustainable food systems that deliver a fairer share of economic benefits for both producers and consumers.

ternational agreements and national regulations on genetic resources and intellectual property to better take into account farmers' access to diverse, traditional and locally adapted genetic resources, as well as farmer-to-farmer seed exchange, and iv) strengthening the regulations on the use of chemicals harmful for human health and the environment in agriculture and food systems, pro-

moting alternatives to their use and rewarding practices that produce without them.
Furthermore, more support should be given to food value chain innovation platforms and innovation. One important recommendation is supporting the development of local and regional markets, processing hubs and transportation infrastructures that provide greater processing and handling capacities for fresh products from small and medium-sized farmers who adopt agroecological and other innovative approaches and improve their access to local food markets.

Performance metrics must consider all environmental, social and economic impacts.

And finally, investments in public and private research and development should be increased and support programmes in agroecological and other innovative approaches (the report shows that funding for research in agroecology is very low compared to conventional agriculture). In addition, investment should be increased to develop and support transdisciplinary research conducted through innovation platforms that foster co-learning between practitioners and researchers, and the horizontal dissemination of experience among practitioners (e.g. farmer-to-farmer networks, communities of practice and agroecological lighthouses).

In the IAASTD (2009) report, agroecology is mentioned relatively few times, although many elements of how it is seen today were already in the report. Agroecology was presented as the science of applying ecological concepts and principles to the design and management of sustainable agroecosystems, including the study of the ecological processes in farming systems and processes. Therefore, the report was referring more to practices without calling them agroecological practices. The report did not include the view on agroecology and food systems as detailed in the HLPE (2019) report, and did not link the importance of agroecological movements to the push for transformation of agriculture and food systems.

Endnote

1 http://www.fao.org/3/ca5602en/ca5602en.pdf

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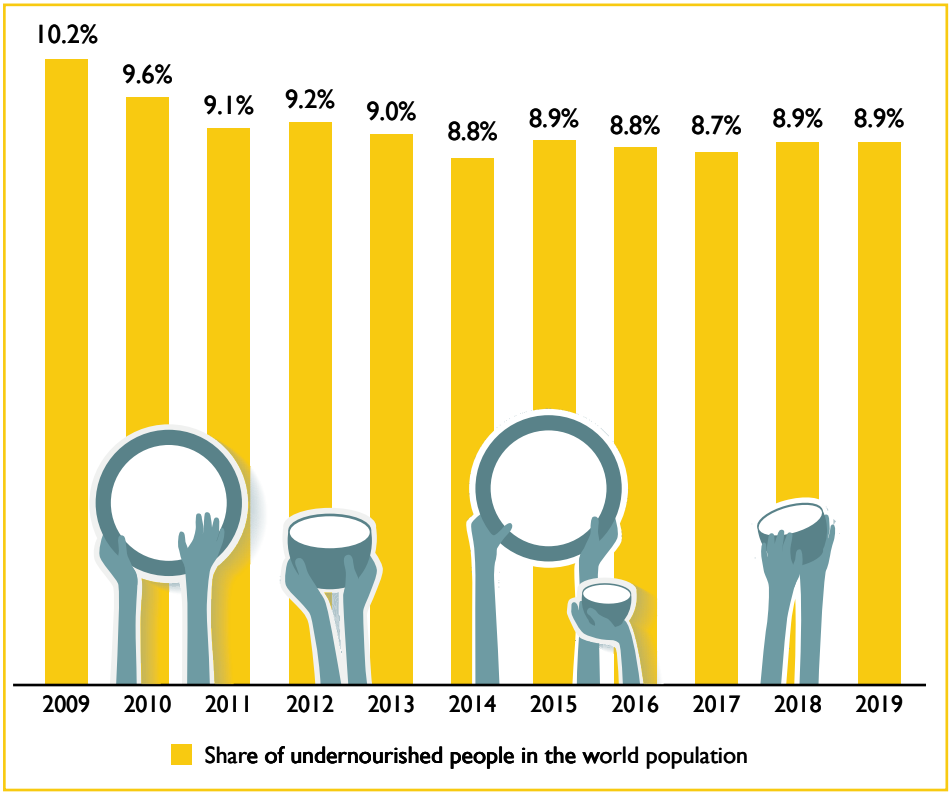
10-Year Comparison

Undernourishment



Prevalence of undernourishment (PoU) worldwide in per cent. FAO's calculation of the minimum dietary energy requirement (global average 2019: 1827 kcal) is based on demographic data for each country, taking into account age and sex, weight, height or physical activity level of the population.

Empty plates and hungry bellies – a constant crisis

Between 2009 and 2019, the prevalence of undernourishment (PoU) in the world declined slightly, and has increased again since 2014. In 2019, almost 690 million people suffered from chronic hunger. This figure is much lower than previously estimated due to a revision of data for China, bringing the PoU for China down to under 2.5%, as compared to almost 10% without this revision. However, the upwards trend of the curve remains and the Covid-19 pandemic may add an additional 132 million undernourished people in 2020. The global figures disguise alarming regional figures: In 2019, PoU was 22% in Sub-Saharan Africa, up from 20.3% in 2014, an increase of 46 million people. In absolute numbers, most of the world's undernourished people live in Asia (381.1 million), followed by Africa (250.3 million). 135 million people worldwide faced acute hunger in 2019.

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Bernard Hubert

The need for a conceptual paradigm shift

Business as usual vs sustainability

The "business as usual" vision tends to consider the living world as an industrial process simply turning inputs into outputs. Following Larrère and Larrère (2015)[1], it is the kingdom of *techne*, creating artifacts, thinking in terms of stability, homogenization, uncertainty reduction, where truthfulness tests rely on the classical "validation" as a universal value. In this vision, there is a separation between human and nature ("naturalism"), and there are normative arrangements, e.g. hierarchies in biodiversity values.

Another way of seeing the living world is to consider it as transforming spontaneous dynamics to be steered and taken care of ("doing with" nature). It is the world of *physis*, where performances are evolving and unpredictable and resources emerging from interactions, and where complexity and diversity are considered as assets. Here, evaluation is expressed in terms of "robustness", i.e. its relevance when put to the test in a diversity of situations. In this vision, culture and nature are considered as the two faces of society. Priority is given to relationships and interactions, environmental feeling, techniques as an emerging process independent of theoretical frameworks, e.g. plant and animal domestication as pure products of the society-nature interface.

Two approaches to sustainability in agriculture: resources sufficiency and functional integrity

This process of establishing understandings in institutions leads to particular practices and policies which may outlast commitments to the understandings on which they were built[2]. Two philosophical approaches to sustainability in agriculture have been distinguished by Thompson (1997)[3]:

1. 'Resource sufficiency' stresses the measurement of the rates at which resources are used in production, distribution and consumption of food. In livestock production, for example, the issue is one of increasing efficiencies, reducing pollution and finding substitutes for scarce inputs. This creates policies that opt for efficiency as the main – even single – assessment criteria by universal norms (productivity: yields/ha/worker/animal).

Agricultural science currently favours 'resource sufficiency' understandings. It identifies two ways to maintain sustainability in light of declining resources: Sustainability requires either a decreasing rate of consumption or an increased efficiency or substitution with other resources. Thus, many technical recommendations regarding rangeland and uses deal with a decrease in stocking rates (in regard of

'carrying capacity') and the introduction of improved pasture, mastered in practices valued as part of modern agricultural paradigms. Research and policy must focus on increasing the efficiency at which scarce resources are consumed, by introducing new technologies with better yields, and in finding substitutes.

2. 'Functional integrity' stresses the vulnerability that may arise from a lack of understanding of the systemic interactions of production practices and innovations with processes of ecological and social renewal. It understands agriculture as a system, which embodies complex and poorly understood value commitments and ecosystem relationships. Here, policy strategies focus on resilience, the avoidance of irreversible effects and systemic understandings designed to mitigate unintended consequences. The issue is to forestall irreversible changes in an agroecosystem and to better understand critical trajectory-changing points.

"Functional integrity" strategies focus on a systemic understanding to mitigate unintended consequences and increase resilience.

The notion of 'functional integrity' presupposes crucial elements that are reproduced over time in a manner or at a rate that is contingent upon previous system states and upon interactions of different living communities within the system. The elements to be maintained might be soil fertility, crops, domestic animal herds, wildlife populations, know-how on management practices or product processing, or even human institutions such as the family, rights regimes, specified markets, or the state. Extensive livestock farming is illustrative, where stocking rates are challenged by herds mobility: forage, non-forage plants such as brush, wildlife, and products (milk, meat, wool or landscape services) exhibit complex relationships. These elements of 'range systems' can remain in a dynamic equilibrium for extended periods of time, but disequilibrium can appear suddenly (or with a substantial time lag) as a consequence of critical changes in the reproductive capacity of any single element. Human practices can threaten functional integrity if they drive the system into states from which reproductive processes cannot recover. At the same time, human practices are part of the system, and functional integrity can be disrupted in many ways, including simple failure to perform an action that is crucial to reproducing some system element or to maintain it in a changing environment (economics, policy, climate change, consumer behaviour),

There is an urgent need to shift to managing ecosystems functionalities

Prioritizing long term food security based on complex agroecosystems relies on new concepts: dynamics, thresholds, resilience, viability kernels, learning processes and collective action, based on co-evolution of a society-environment relationship facing uncertainties. We are not in a stable (or foreseeable) environment and need to manage or steward ecosystems functionalities in order to facilitate 'ecosystem services', building 'capacities', adapting to changes, and not being steered by a set of technologies.

Making changes in our social systems relies on how knowledge capacities, social institutions and human incentives can be regenerated, taking care of the coexistence of a pluralism in concepts and approaches in order to 'act always so as to increase the number of choices' (following von Foerster, 2002)[4]. Cultural perspectives on the relationship between nature and culture must change to give priority to relationships and interactions, rather than emphasizing the split between humans and nature.

Endnotes

1 Larrère C. et Larrère R., 2015 : Penser et agir avec la nature. Une enquête philosophique. Ed. La Découverte, Paris, 334 p.

2 Hubert B; and Ison R., 2011: Institutionalising understandings: from resource sufficiency to functional integrity. In A paradigm shift in livestock management: from resource sufficiency to functional integrity. Kammili T., Hubert B. and Tourrand J.-F., Dirs., Cardère Ed. : 11-16.

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4 von Foerster, H. & Poerkson, B., 2002: Understanding Systems. Conversations on Epis¬temology and Ethics. IFSR International Series on Systems Science and Engineering, 17. Kluwer Academic, New York and Carl-Auer, Heidelberg.

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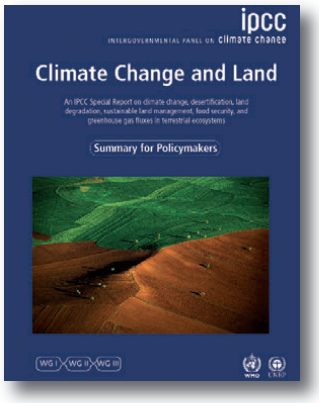
Marta G. Rivera-Ferre

The contribution of the IPCC to a change of paradigm in agriculture and food systems

In 2019, the IPCC published a Special Report on Climate Change an Land[1], which for the first time has applied a system's approach in the assessment of food in the context of climate change. This report follows a holistic view, analysing land from a food security perspective and potential adaptation and mitigation options. The report concludes that deep changes in governance are needed to address the land, food and climate change challenges.

Agri-food systems have multiple interactions with global environmental change. For instance, five of the nine planetary boundaries are directly linked to agri-food systems as well as thirteen out of the seventeen sustainable development goals (SDGs). However, in their current form, agri-food systems do not fulfil their main objective of providing sufficient healthy and nutritious food to people without harnessing the environment. The most important challenges agri-food systems are facing include mitigation and adaptation to climate change, food security, social justice, public health and environmental sustainability. Given these multiple dimensions, assessing agri-food systems linkages with climate change requires understanding of the complex problems where conflicting interests, cultures, and worldviews exist (Thompson and Scoones 2009; Rivera-Ferre et al., 2013). This complexity is the point of departure of the IPCC "Special Report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems", shortly known as the Report on Climate Change and Land (SRCCL).



Using land as the central focus, the SRCCL recognises that land plays a central role in people's wellbeing, and particularly in the provision of food. Land is analysed from a broad perspective, integrating the human and nature dimensions of land, as well as the impacts of climate change on land systems and the potential adaptation and mitigation options, including synergies and trade-offs. This integrated analysis embraced the

multiple direct and indirect drivers of natural resource management (related to food, water and energy securities). Indeed, roughly 49% of ice-free land is directly used to produce the food we eat and agriculture uses about 70% of global fresh water use. But about a quarter of ice-free land is subject to human-induced degradation endangering the livelihoods and food security of billions of people, and climate change can exacerbate these degradation processes. Thus, following a holistic view, the report looked at land from a food security perspective (including all four dimensions of food security), also referring to the strong correlations between land degradation and poverty. Under the message that land is under growing human pressure, the SRRCL suggested that land is also part of the solution to climate change. From 2007-2016, land has acted as a carbon sink removing about one third of total CO2 emissions and one fifth of total greenhouse gas (GHG) emissions (IPCC, 2019). But for land being able to be part of the solution, substantial changes regarding how we manage land and how we produce and eat food are required. In other words, the report calls for a transformation of the system.

49% of ice-free land is directly used to produce the food we eat, and agriculture makes up for some 70% of global fresh water use.

To properly explore how we can transform agriculture and food systems, a systemic approach to food is required. This allows understanding the close relationship between the different components of the system (from production to consumption), develop supply-side (e.g. livestock and crop production) and demand-side (e.g. dietary change) options and analyse how they behave both in terms of adaptation and mitigation, including the role that different actors play in the system. Otherwise, fragmented and sectorial analyses, studying only one part of the reality deliver wrong and too generic conclusions. One example of this was the highly-repeated message that due to the expected growing population we needed to produce 50% more food by 2050 (FAO 2017). Despite the fact that we clearly need to increase the production of food in some parts of the world, this message, based on demographic and consumption trends, did not consider what happens along the food chain in terms of food loss and waste, nor the current overconsumption trends in many parts of the world. Thus, this number has now been contested (HLPE, 2019).

From 2007-2016, land has acted as a carbon sink removing about one fifth of total greenhouse gas emissions.

With regard to the GHG emissions related to the production and consumption of food, the SRCCL estimates a significant contribution of 21-37% of total anthropogenic emissions, of which 14-28% correspond to agriculture and land use and 5-10% correspond to emissions outside the farm gate (Table 1). Considering that approximately one third of the produced food is never consumed, it is estimated that food losses and waste along the food chain constitute 8-10% of total GHG emissions. But emissions and land uses are not isolated from consumption patterns, they reinforce each other. In the last decades, global

Food system component	Emissions (Gt CO_2eq yr^{-1})	Share in mean total emissions (%)
Agriculture	6.2 ± 1.9	9-14%
Land use change (e.g. deforestation)	4.9 ± 2.5	5-14%
Beyond farm gate	2.6 – 5.2	5-10%
Food system (Total)	10.8 – 19.1	21-37%

Table 1. GHG emissions (Gt CO_2eq yr^{-1}) from the food system and their contribution (%) to total anthropogenic emissions. Mean of 2007-2016 period.

diets have transitioned towards ultra-processed food and increasing animal food products that we can source from different parts of the world.

Thus, from the SRCCL we understand how food systems contribute to climate change, but we also need to assess the potential mitigation and adaptation (M&A) options to climate change both from the demand and supply sides. The SRCCL puts special efforts in assessing the synergies, trade-offs and co-benefits between M&A of the different options analysed, that is, which of these options allow to reduce GHG emissions, adapt to climate change, and ideally, contribute to carbon sequestration. In the executive summary of chapter 5 of the SRCCL we can read: *"Supply-side options include increased soil organic matter and erosion control, improved cropland, livestock, grazing land management, and genetic improvements for tolerance to heat and drought. Diversification in the food system (…) is a key strategy to reduce risks (medium confidence). Demand-side adaptation, such as adoption of healthy and sustainable diets, in conjunction with reduction in food loss and waste, can contribute to adaptation through reduction in additional land area needed for food production and associated food system vulnerabilities. ILK can contribute to enhancing food system resilience"* (Mbow et al., 2019).

As an example on the supply-side, increasing soil organic matter and erosion control contribute to mitigation through carbon sequestration and reduced GHG fluxes in terrestrial ecosystems and to adaptation through increases in fertility rates, reduction of evapotranspiration, making soil less vulnerable to drought; and reduction of soil erosion, making the soil less vulnerable to flooding. On the demand side, by reducing the demand to produce resource intensive food, emissions are proportionally reduced. Adding to this, pressure on land is also reduced so more land is available to other uses, including afforestation and

reforestation, contributing also to carbon sequestration or to reduce land conflicts. It is estimated that by 2050, dietary changes could free several million km2 of land and provide a technical mitigation potential of 0.7 to 8.0 $GtCO_2e\ yr^{-1}$, relative to business as usual projections (Mbow et al., 2019).

And, what is the relationship with the IAASTD (2009)? First, both reports conclude that *"business as usual is not an option"*. Further, some of the SRCCL messages are very close to those delivered by the IAASTD ten years earlier. Of those, I highlight: i) the relevance of indigenous knowledge and local knowledge (ILK) in achieving sustainable food systems and just development; ii) the need of biodiversity enhancement in the food chain and the importance of agroecological practices; and iii) the need to empower women as main actors in provisioning food for their families.

The relevance of indigenous and local knowledge in achieving sustainable food systems

ILK has been proposed as one type of strategy capable to foster transformational adaptation (IPCC, 2014). It refers to the know-how accumulated across generations, however, it is rarely considered in the design and implementation of modern M&A strategies since it has been considered a rudimentary form of thinking. The last decade, however, showed an increased interest in ILK as a source of information for sustainable development policies. ILK is strongly associated with sustainable management of natural resources (including land), and with autonomous adaptation to climate variability and change (Morton et al., 2019). Across diverse agroecological systems, ILK is the basis for traditional practices to manage the landscape and sustain food production, while delivering co-benefits in the form of biodiversity and ecosystem and food systems resilience (Mbow et al, 2019; Morton et al., 2019). In the SRCCL, ILK plays a central role (see chapters 5 and 7). Particularly, agriculture based on ILK that focuses on diversification, soil management, intercropping and rotational cropping, sustainable water harvesting and local irrigation systems holds promise for long-term resilience and rehabilitation of degraded land. ILK can also play an important role in ecological restoration, including for carbon sinks, through knowledge surrounding species selection and understanding of ecosystem processes (Morton et al., 2019).

Food losses and waste along the food chain constitute 8-10% of total greenhouse gas emissions.

Biodiversity enhancement and the importance of agroecological practices

The SRCCL gives a prominent role to diversification along the food chain, including dietary enhancement in the consumption of foods to achieve healthy and sustainable diets, in contrast to the homogenization process experienced in the last decades (see chapters 5 and 6). Dietary diversity has also been correlated to agricultural diversity in small-holder and subsistence farms (Mbow et al., 2019). Diversification of many components of the food system is then a

key element for increasing performance and efficiency that may translate into increased resilience and reduced risks (Mbow et al., 2019). On-farm biodiversity conservation is considered as an M&A practice, particularly together with the use of agroecological practices, and with neglected and underutilised species playing a central role (Mbow et al., 2019). In the SRCCL, attention is paid to the need to favour seed sovereignty.

Smith et al. (2019) suggest that the promotion of local seed-saving initiatives, including seed networks, banks and exchanges, and non-commercial open source plant breeding, can help protect local agrobiodiversity and can often be more climate resilient than generic commercial varieties, although the impacts on food security and overall land degradation are inconclusive. They document the increased ability of farmers to revive and strengthen local food systems and that studies have reported more diverse and healthy food in areas with strong food sovereignty networks, with women, in particular, getting more benefits from seed banks for low-value but nutritious crops.

The need to empower women

With their central role in the households, women have been responsible for the food and nutritional needs of their families. They prepare, process and preserve food in the house and also work with men in the agricultural fields to produce and harvest food. They are responsible to store the seeds, to transplant the paddy, to grow vegetables for domestic consumption and commercial use and to root out the weeds in the fields. Also in livestock keeping women play a direct role in animal feeding, disease management, management of housing environment and milk processing (Habib 2011). Women are often more linked to small-scale, agroecological projects and subsistence agriculture where ILK and biodiversity play a central role.

Local seed-saving initiatives and open source plant breeding can often be more climate resilient than generic commercial varieties.

The SRCCL acknowledged that gender is a key axis of social inequality that intersects with other systems of power and marginalisation – including race, culture, class/socio-economic status, location, sexuality, and age – to cause unequal experiences of climate change vulnerability and adaptive capacity. For that reason, the report calls for using a framework of intersectionality to integrate gender into climate change research in order to recognise overlapping and interconnected systems of power (Hurlbert et al. 2019). Given women's strong presence in agriculture provides an opportunity to bring gender dimensions into climate change, particularly regarding food security, since impacts of climate change have strong gendered impacts in all four dimensions of food security. The point of departure is that marginalised social groups have their own capabilities to adapt to climate change but gender norms and power inequalities also shape the ability of men, women, boys, girls and the elderly to adapt to climate risks (Mbow et al. 2019). Women's adaptive capacity is also diminished

because their work often goes unrecognised (Rao 2005; Nelson and Stathers 2009).

Many of women's activities are not defined as 'economically active employment' in national accounts. This non-economic status of women's activities implies that they are not included in wider discussions of priorities or interventions for climate change. Their perspectives and needs are not met; and thus, interventions, information, technologies, and tools promoted are potentially not relevant, and can even increase discrimination (Mbow et al., 2019). Thus, an assessment of gender-differentiated needs and priorities and the selection of appropriate policy instruments to address barriers to women's sustainable land management are required. If women had the same access to productive resources as men, the number of hungry people in the world could be reduced by 12–17% (Hurlbert et al. 2019). Empowered women are crucial to creating effective synergies among M&A and food security but this may include targeting men in integrated agriculture programmes to change gender norms and improve nutrition (Mbow et al., 2019).

Enabling conditions: changing governance

The SRCCL concluded that deep changes in governance are needed to address land, food and climate change challenges. In this regard, it is stated that "weak grassroots institutions characterised by low capacity, failure to exploit collective capital and poor knowledge sharing and access to information, are common barriers to sustainable land management and improved food security" (Smith et al., 2019). The UN Committee on World Food Security is seen as an opportunity to address food systems governance challenges, where diverse actors, voices and narratives are integrated in the global food security governance.

Endnote

1 See https://www.ipcc.ch/report/srccl/

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Tirso Gonzales & Walter D. Mignolo

Indigenous autonomy and indigenous community-based research

This essay assesses the relevance of the "development" concept in relation to Indigenous peoples, focusing on three global co-existing scenario-options: re-westernization, de-westernization[1] and Buen Vivir (also known as "Living Well").

The two different concepts of state led development that are commonly used within globalization are 'Rough Unsustainable' and 'Sustainable Development'. Both originated in Western cosmology[2] to benefit the state and a few corporate businesses, both are based on "growth", presuppose an economy of "accumulation" and exploitation. They both lead to increasing inequality and assume that society is part of the economy rather than the economy being an aspect of socio-cultural organizations (Table 1).

The design and implementation of this kind of "development" (Sachs 2010) is based on a system of ideas, beliefs, emotions, and institutions that are distinctly different from Buen Vivir. At the foundation of Buen Vivir is Indigenous autonomy and Indigenous community-based research (ICBR) that nurtures life as a whole. This is a conceptual approach arising especially from Indigenous peoples emphasizing living in harmony with nature. Yet despite Indigenous food systems' contribution to feeding the world, the IAASTD paid little attention to Indigenous autonomy and ICBR. Nevertheless, despite chronic research funding shortages, both have continued to grow and innovate on most continents, while enabling different types of Indigenous learning to boost Buen Vivir across multiple dimensions (Tebtebba 2010, 2012, 2008, PRATEC 1998).

The "Sustainable Development" option is not conducive to Indigenous peoples' food production or ancestral vision.

In 2008, IAASTD proposed "equitable and sustainable development" as the goal for food systems, identifying agroecology as a pathway. But in spite of the IAASTD's attention to equity, the "Sustainable Development" option is not actually conducive to Indigenous peoples' food production or ancestral vision, mission, and strategy, which is necessary to achieve Buen Vivir – procuring balance and harmony for life as a whole (Table 1). The 2007 UN Declaration of the Rights of Indigenous Peoples (UNDRIP) provides a clear roadmap for achieving Buen Vivir. Yet to date, most countries that approved the IAASTD have continued to disregard UNDRIP (Tebtebba 2012, 2010; Gonzales 2015).

Coexisting Trajectories	RE-WESTERNIZATION: IAASTD and Agroecology at a Crossroads		*BUEN VIVIR*, "Living in Harmony & Plenitude" *(Sumak/Sumaq Kawsay, Suma Qamaña)*
	Rough Unsustainable Development (RUD)	**Sustainable Development (SD)**	**Sustainable Economies (SE)**
	Originated in Cosmology of Western Civilization for the benefit of the State and a few corporate interests		Originated in Indigenous Cosmologies (e.g. Andean-Amazonian) for the benefit of life as a whole
	Conventional Development is based on "growth", exploitation, & "accumulation"	**Changes the *Contents* of the conversation**	**Changes the *Terms* of the conversation**
Options	**RUD Re-Westernization (State led)** • Society is part of the economy rather than the economy being an aspect of socio-cultural organizations. • Imposes Western framings, theories, discourses and models via a transnational network of national and supranational institutions (e.g. UN, World Bank, IDB, IMF, aid treaties, regional research institutes, trade regimes, economic sanctions or rewards, corruption, education). • Development; and rural & agricultural developmoent state policy: neoliberal, corporate (agri)business oriented. • Manipulative, restricted use of SD-agroecology. • Human beings are disposable. • Individuals are at the core of welfare/development. • Nature & indigenous/local cultures are excluded from its economic equation. • Lacks spiritual depth, self-centered.	**SD Re-Westernization (State led)** • Society is part of the economy rather than the economy being an aspect of socio-cultural organizations. • Proposes a correction of RUD within Western cosmology. • Maintains the concept of development. • Ecology and agroecology are selectively incorporated by stakeholders within dominant conventional sustainable development. • Developing states support private sector agroecological products for export and less so for healthy national mass consumption. • Scant state reception to agroecological proposal from social movements / organizations (e.g. La Via Campesina). • In theory may solve issues such as "Global Warming", but cannot and does not intend to solve issues such as global inequality. • Individuals are at the core of welfare/development. • Lacks Agro-Festive & Ritual Calendar(s).	***Buen Vivir* – Living in Harmony & Plenitude** • Delinking from the idea of development and state policy. • Would lead to shifting our visions of living on the planet & reducing both RUD & SD down to size. • Sustainable Economies are grounded in normativity of Indigenous Cosmologies & praxis of living ("Cosmo-con-vivencia"). **Conviviality** is part of the community. • Development is not its goal. • Reduces down to size any economic philosophy, concepts based on developmental principle. • Sustainable Economies are a different & more effective option if the real goal is to eliminate poverty and inequality, ensure health & education for all, and reduce global warming. • Goal is balance & harmony among humans & all living visible & invisible beings/organisms on the planet. • With harmony, rather than development as the goal, inequality would be addressed before it happened. • Community is at the core of wellbeing. • Rich variety of sophisticated Agro-Festive & Ritual Calendars (based on local, spiritual, and cosmological knowledge & wisdom).

Table 1: Agroecology & Buen Vivir and state led global scenarios. Source: Elaborated by Tirso Gonzales. Based on Mignolo, 2016; Gonzales & Hussain, 2016; Sachs 2010

Sustainable development, indigenous autonomy and ICBR in the globalization scenarios

Although Sustainable Development has all the institutional support of the United Nations and is strongly positioned to mitigate the disastrous consequences of Rough Unsustainable Development, this cannot happen using the same mindset that created them. In the current political globalization scenarios, we have a tension between re- and de-westernization. While the USA, European Union and allies are trying to re-install Western dominance, other powers – such as the BRICS-countries – work towards an end of the Western or US-Dollar dominance.

Both, the Rough Unsustainable and the so-called Sustainable Development share the same definition of development that precludes the possibility of thinking of Indigenous Sustainable Economies and Buen Vivir. Similarly, the dispute between Rough and Sustainable Development permeates the tension between re- and de-westernization. The formation of BRICS countries de-link in many ways from Western designs, but does not question "development" (e.g. China) as the only possible horizon for a global economy.

The UN´s 17 Sustainable Development Goals (SDGs) must be understood in the context of the multipolar global order of today and tomorrow. The UN is an institution conceived, epistemically and politically, within the parameters of Western cosmology. When the UN launched the SDGs in 2015, de-westernization was very well advanced. In this multipolar world order, sustainable development was negotiated between the interests of re-westernizing the planet and the nega-

tion of the interests of de-westernization advocates. Consequently, the Sustainable Development proposal sought to mitigate the harms of Rough Unsustainable Development, but fell short of proposing a radically new vision for living.

Sustainable Economies

There is however a third approach-scenario, "Sustainable Economies", which delinks economies from the SDGs and from re- and de-westernizing state-led projects alike. The Sustainable Economies Project follows neither one of the "Development" approaches nor the IAASTD, but is based on Indigenous cosmologies and praxes of living. After IAASTD, the challenge remains to embrace a new mindset that allows us to think of de-linked Sustainable Economies. For these to flourish, we must learn from, support and interact with Indigenous cosmologies and praxes. Sustainable Economies shall be created and managed by Indigenous leaders and communities (Tebtebba 2012, 2010; Mignolo 2020, Esteva 2015).

Support indigenous community-based research and Buen Vivir

Indigenous community-based research is embedded in and informed by the Indigenous cosmologies of Buen Vivir and has its own methods, indicators and validation systems. Dialogue and collaboration is imperative between Sustainable Development-agroecology stakeholders and Buen Vivir Indigenous practitioners. Foreign aid actors should learn from the small Euro-American funding institutions that support Indigenous autonomy and ICBR. This would upscale the co-production and cross-fertilization of agricultural knowledge and strengthening of Indigenous agricultures (Tengö 2017).

ICBR has been successfully tested and validated its methods with a variety of Indigenous Think-Tank institutions such as the Tebtebba Foundation, PRATEC; AGRUCO and the Universidad de la Tierra as well as with Indigenous NGOs, a cluster of European-funded individuals and institutions and the scholarly fields of Indigenous and Modernity/Coloniality Studies (Gonzales & Hussain 2016, Tebtebba 2012, 2010).

Indigenous autonomy has its own resolve (Esteva 2015) and has been imprinted in the expression Sumak Kawsay in Quichwa, Suma Qamaña in Aymara, and translated into Spanish as Buen Vivir and adopted by non-Indigenous "Latin" Americans. Buen Vivir encourages sustainable development and agroecology supporters to look forward at the same time that they look backward (Ñawpaman Puni, in Quechua) and "becoming Native to this Place" (Jackson 1994). By becoming native to the place, country and planet human beings make the Rough Unsustainable Development untenable.

The challenge re- and de-westernization face is to take seriously the paradigm of diverse and sustainable economies. The "development" concept is simply not relevant.

Endnotes

1 De-westernization´s main characteristics are political and economic rather than geographic and refer to all countries that desire an end to international dependency based on the legacies of the 1944 Bretton Woods Conference and the US dollar's global dominance and that delink from economic decisions made by the WB, IMF, United States and the European Union.

2 Cosmology and cosmo-vision are two Western concepts, one underlining the logos and the other the eyes, shattering all other forms of expressing the experience of Pachamama, which is the Quechua-Aymara equivalent to the regional Greek cosmos and Latin universum. Aymara intellectuals talk about 'cosmo-con-vivencia', that is, the experience of the cosmos (vivencia) as well as living in harmony with the cosmos (convivencia, that is, con-viviality).

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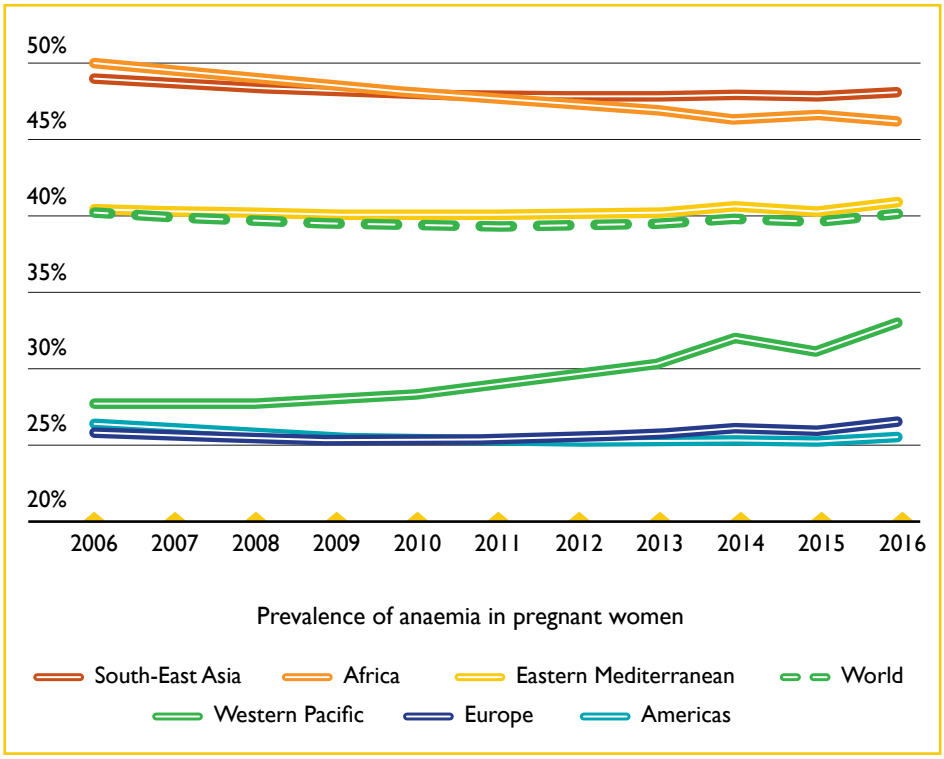
Micronutrient deficiencies



Prevalance of anaemia in pregnant women aged 15-49 by WHO region, defined as the percentage of women with a haemoglobin concentration of less than 110 grams per litre for pregnant women

Malnutrition – a triple whammy

Undernutrition, being overweight and obese, and micronutrient deficiencies are frequently referred to as the "triple burden of malnutrition". Two billion people across the globe are estimated to suffer from micronutrient deficiency, also termed hidden hunger, which is characterised by a lack of important vitamins and minerals. Iron deficiency is the most common cause of anaemia, which mostly affects young children and women of reproductive age. Between 2006 and 2016, the prevalence of anaemia in women of reproductive age increased globally from 30.4% to 32.8% and remained at around 40% in pregnant women. In 2012, the World Health Assembly set the target of a 50% reduction of anaemia in women of reproductive age by 2025. Anaemia according to pregnancy status has now also been included as an indicator for Sustainable Development Goal 2.

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Lauren Baker, Barbara Gemmill-Herren, Fabio Leippert

Beacons of hope: accelerating transformations to sustainable food systems

In 2019, the Global Alliance for the Future of Food and Biovision Foundation for Ecological Development published the report "Beacons of Hope: Accelerating Transformations to Sustainable Food Systems."[1] The report illustrates the positive impacts of food systems on the environment, livelihoods and health. The initiatives selected as Beacons of Hope are not only a source of inspiration for food systems transformation, but also help to better understand how to support and facilitate these transformative processes.

IAASTD's Legacy

The questions you pose dictate the answers you get. For some, the central question asked related to the future of food is "how can net calorie availability be delivered in the most efficient way possible?" For others it is "how can we feed all people well and equitably through a diversity of channels without harming the planet?" In 2009, IAASTD posed the question: "how can we reduce hunger and poverty, improve rural livelihoods and facilitate equitable, environmentally, socially and economically sustainable development through the generation of, access to, and use of agricultural knowledge, science and technology?" Through the process of exploring and answering the question IAASTD created a conceptual framework for food systems transformation that informed our work on the "Beacons of Hope" report. In the Beacons of Hope report we sought to understand "how do we accelerate the transformation toward healthy, equitable, renewable, resilient, inclusive, and culturally diverse food and agriculture systems?" Embedded in the questions are inherent objectives for the food system, and either narrower or broader conceptual frameworks for addressing food system challenges and opportunities in the 21st century. IAASTD positioned these food systems objectives as broad and interconnected, with the potential for facilitating a number of co-benefits across the system. There are three ways that IAASTD continues to inform the global discussion:

1. By introducing a holistic systems perspective: examining food systems in the context of both the full value chain – from inputs to consumption and waste – and a wide breadth of interconnections and impacts;
2. By promoting an inclusive process to generate the report and compile relevant knowledge: interdisciplinary, both regional and global, multi-thematic, multi-spatial, multi-temporal, multi-stakeholder and intergovernmental, open and transparent in relationship to mechanisms for input and peer review;
3. By considering diverse knowledge and evidence: not only scientific, but other relevant knowledge paradigms including Indigenous, farmer and traditional knowledge, the role of diverse institutions, governance, markets, and trade. Historical analysis was considered, as well as future-casting to 2050 in order to inform recommendations.

This framework for considering food systems is more relevant than ever as we grapple with the complexity of climate, biodiversity, health and equity challenges and the ways they manifest locally and globally. It is important to remember that 10 years ago, when IAASTD was published, few were talking about food systems transformations. Over the last year there have been multiple reports published and processes calling for systems transformations, with the recognition that multiple transformations across food systems are critical to meet the Sustainable Development Goals, biodiversity and climate targets.

MASIPAG, PHILIPPINES: Agricultural biodiversity and resilient seed systems

MASIPAG[2] is a longstanding, farmer-led network of civil society organizations, NGOs, and scientists in the Philippines. It reaches about 35,000 farmer members in 3 regional zones of the Philippines. The goals are to sustainably manage biodiversity through farmer-controlled seeds and biological resources, agricultural production, and associated knowledge. MASIPAG was created to break the control of local and multinational fertilizer and pesticide companies, multilateral rice research institutes, and rice distribution cartels. To improve the quality of life of small farmers, the initiative takes a holistic approach to development, community empowerment, and people's control of agricultural biodiversity. MASIPAG's approach to empower farmers in breeding their own local rice varieties and to collaborate with academic sectors uses the following interactions: bottom-up decision–making, planning and implementation; farmer–scientist partnerships; farmer-led research; farmer–to–farmer modes of diffusion in training; and advocacy on farmers' rights issues.

About Beacons of Hope

Several years ago, the Global Alliance for the Future of Food and Biovision Foundation for Ecological Development[3] set out to better understand the possibilities and pathways for food systems transformation globally, across different contexts and in different places. We were looking for counterpoints to the daunting news of the climate emergency, ecological crisis, growing inequalities, and

skyrocketing costs of diet related diseases. The "vicious cycle" of negative impacts of food systems (IAASTD Global Report, 2) is well articulated in the IAASTD report. But what are the positive impacts of food systems managed for health, equity, resilience, renewability, inclusivity and diversity?

Global Alliance for the Future of Food members and Biovision Foundation for Ecological Development have the great privilege of supporting a wide range of food systems initiatives seeking to address these interrelated crises. We wanted to illustrate the positive impacts of food systems so clearly described in the IAASTD (Global Report, 21).

Around the world "Beacons of Hope" are working to transform food systems. Thousands of initiatives are contributing inspiring, creative, and necessary solutions to urgent global issues such as climate change, migration, urbanization, and the need for healthier communities and more sustainable diets. The Beacons of Hope report sought to amplify their stories and better understand their impact in order to strengthen our understanding of the transformation process.

To uncover the diversity of approaches, we asked our networks to share their Beacons of Hope. We then worked through a rigorous selection process to identify 21 initiatives that were geographically dispersed, worked across scales and issues, reflected work by different sectors, addressed multiple dimensions of food systems, illustrated a holistic approach, and articulated a change or transformation processes. The initiatives selected are not only a source of inspiration for food systems transformation, but also help us better understand how to support and facilitate these transformative processes in place-based, contextual ways.

EOSTA, NETHERLANDS: Toward the true cost of food

This award-winning private–sector initiative is dedicated to the production and importation of sustainable, organic, and fair trade fruits and vegetables. Eosta[4] is an international distributor with relationships with over 1,000 growers in six continents. They provide full traceability of their products, provide extension services to farmers, promote true cost accounting, and build a sustainable market with consumers. This traceability allows consumers to make well–informed purchases at prices fair to producers, society, and the environment. As "orchestrators of the production and supply chain," Eosta provides agroeconomic advice, finances, packaging, product innovation, logistics, marketing, and distribution to their customers.

A pillar of EOSTA's approach is transparency through true cost accounting. True cost accounting is an evolving approach and methodology to make visible the full costs of food by identifying, measuring, and valuing the positive and negative environmental, social, and health externalities of food and agricultural systems.

Understanding sustainability transitions

To better understand sustainability transitions more broadly, and food system transitions more specifically, we reviewed the sustainability transitions literature focusing on contributions from: 1) Harriet Friedmann and Philip McMichael (1989), who trace the legacies of historic "food regime" transitions; 2) Hill and MacRae (1996) and Gliessman (2016), who explore agriculture and food system transitions, and have developed frameworks to assess and guide the depth of these transitions; and 3) the "Multilevel Perspective" elaborated by Geels (2002) and others to describe broader sustainability transitions.

Throughout history, food systems have undergone a process of continuous change. In this context of constant change, where have significant transformations occurred? Friedmann and McMichael (1989) trace the legacies of historic "food regimes" – major transformations that have shaped labour, agriculture, markets, diets, social movements, and nation-state systems. Their analysis of these transformations helps us understand transitions as dynamic, contested, historic, systemic, and connected to and influencing broader social, political, and economic processes.

In 1996, Hill and McRae explored possible transitions from conventional to sustainable agriculture, developing the Efficiency-Substitution-Redesign Framework. This framework has been adapted to apply to the food system as a whole. Gliessman (2016) extends Hill and MacRae's Efficiency-Substitution-Redesign Framework to analyze five levels of agroecological food systems transitions. The Hill and MacRae and Gliessman frameworks helped us to: a) conceptualize transition phases; b) evaluate the depth of transitions; c) distinguish between incremental and transformational change; and d) identify transformative elements of the transition process as we developed the food system transformation framework. Theoretical constructs for sustainability transitions beyond food systems are also instructive. Sustainability transitions are seen as processes that are long term, multidimensional, and creating fundamental transformations that cause shifts in established socio-technical systems to more sustainable modes of production and consumption (Geels 2002 and 2011). The environmental and social problems that sustainability transitions are addressing generally require many years, if not decades, for the full effect of changes to take place, and inevitably involve multiple solutions rather than "silver bullets" (Lachmann 2013).

Food system transition pathways are less technology-oriented, and instead depend on social processes of learning

The "Multilevel Perspective" elaborated by Geels is a well-known and debated transition theory. When reviewing the literature and discussing the MLP with sustainability transition experts it became clear that applying the MLP to food systems is a challenge. Energy and transportation sustainability transitions can more easily be mapped to a set of technological solutions and to how technological changes are incorporated in social functions (Geels 2002). In contrast, food system transition pathways are likely less technology-oriented, and instead depend on building

social networks and social processes of learning. Nonetheless the MLP concept of "niches" – initiatives that promote alternatives to the dominant practices and rules and that can serve as transformative elements – has shown itself to be useful concept applied to Beacons of Hope.

Sustainability transitions often focus on the trajectory of specific technology "innovations" and the consequent changes in user practices, regulation, industrial networks (supply, production, and distribution), infrastructure, and symbolic cultural meanings (Geels 2002). While these aspects are relevant to the food system as well, sustainable food systems transitions will need to address how to introduce change into the additional complexity and diffuseness of food systems and consumer behaviour (Anderson et al 2019; Gaitán-Cremaschi et al 2019). The transitions literature above was adapted for the purposes of understanding the transformations occurring throughout the Beacons of Hope. Terminology was changed to wording that is more meaningful in the context of our project, focusing on food systems transformations. Figure 1 illustrates our conceptualization of the food systems transformation process.

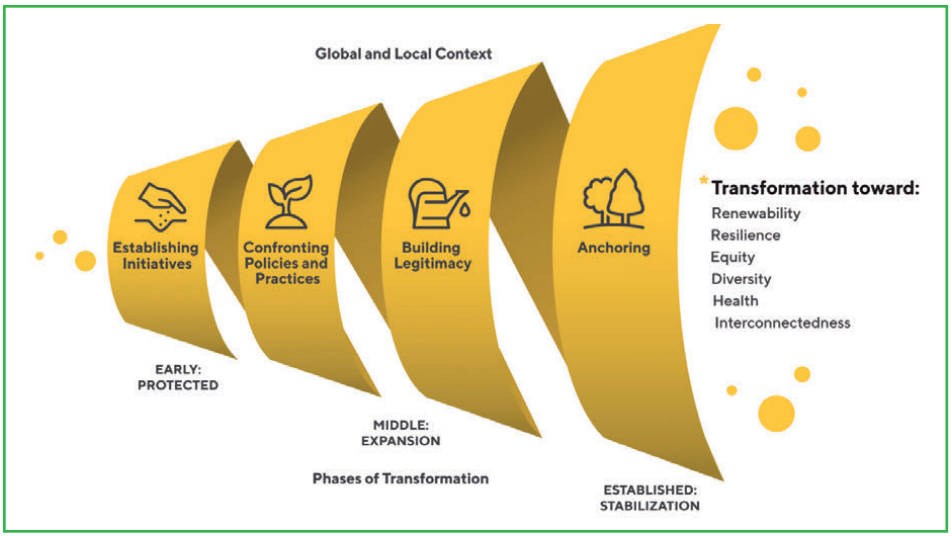

Figure 1: Beacons of Hope food systems transformation framework

From our analysis of the Beacons of Hope case studies, key elements in the transformation to sustainable food systems were identified. These included: protecting, promoting, and supporting family farmers and Indigenous communities producing food using agroecological and diversified approaches and principles; co–creation of knowledge, and knowledge exchange and dissemination; developing cooperative ownership models; emphasizing ideas of circular and solidarity economy; reinforcing the importance of culturally relevant and place–specific sustainable diets; establishing participatory approaches and inclusive governance;

identifying new market mechanisms; adopting new holistic metrics; and, engaging in policy development.

Most significantly, the Beacons of Hope work contributed to the development of a Theory of Transformation adopted by the Global Alliance for the Future of Food. This theory of transformation recognizes that when diverse actions, networks, and individuals intersect and converge across sector and issue silos, the global and local, the macro and the micro, critical mass and momentum builds toward tipping points that lead to systemic change that endures over time.

COMMUNITY MANAGED NATURAL FARMING, ANDHRA PRADESH, INDIA: Agroecological transformation

The Community Managed Natural Farming[5] approach, led by the Government of Andhra Pradesh's Department of Agriculture, is on target to engage 1 million farmers by 2019–2020 to increase yields and promote resilience through agroecological processes. It is a broad state policy with multiple objectives including enhancing farmers' welfare, consumer welfare, and the conservation of the environment. The work is done through farmer–to–farmer mentoring, short tutorials and films, and modern communication methods.

Transformation pathways

Going forward, we are building on and deepening this important work. A vibrant network of change agents has been engaged in the Beacons of Hope and we see great potential to link these initiatives, deepen our analysis about food systems transformations, better understand transformation pathways, and build the evidence of their positive impacts. The next phase of Beacons of Hope includes linking this work into the global policy agenda and forging local-global linkages. We return now to the central contribution of IAASTD articulated above. By introducing a holistic systems perspective, promoting an inclusive process, and considering diverse knowledge and evidence, IAASTD continues to inform and guide our systemic view, our approach, the breadth of knowledge and diversity of research methods and evidence needed to navigate the complexity of food systems transformations in the current political and ecological moment.

Endnotes

1 https://foodsystemstransformations.org/wp-content/uploads/2019/08/BeaconsOfHope_Report_082019.pdf

2 https://foodsystemstransformations.org/masipag/

3 The Global Alliance for the Future of Food is a strategic alliance of philanthropic foundations working together and with others to transform global food systems now and for future generations. Biovision Foundation for Ecological Development is a not–for–profit, non–denominational, politically independent foundation based in Zürich, Switzerland that supports the dissemination and application of sustainable ecological approaches to alleviate poverty and improve food security in Africa and beyond.

4 https://foodsystemstransformations.org/eosta/

5 https://foodsystemstransformations.org/climate-resilient-zero-budget-natural-farming-cr-zbfn/

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Fabio Leippert works in Biovision's Policy & Advocacy Team on issues relating to agroecology and climate change at the international level as well as at the country level. He holds a Master in Conservation Biology and an MAS ETH in development cooperation. As a biologist he is particularly interested in the dynamics between biodiversity, climate change and agriculture and a systemic and sustainable approach to agriculture and food systems.

Colin R. Anderson & Molly D. Anderson

Resources to inspire a transformative agroecology: a curated guide

Introduction

Since publication of the IAASTD reports in 2009, agroecology has come into its own. Debates continue about the definition, the impact, the potential and the future of agroecology (De Schutter 2011; Anderson et al. 2019a); however, it is generally agreed that the development of agroecology is critical to address the deepening food systems related crises (IPES-Food 2016; Nyeleni 2015). There is growing evidence of the potential of agroecology as a paradigm for a more just and sustainable food system (HLPE 2019) and, with this, a great deal of effort in social movements, academia, institutions and governments to advance agroecology. Indeed, since the IAASTD, there is a wide range of materials that have been published to inspire, evidence and promote agroecology. This chapter curates a selection of publications and resources that showcase different aspects of agroecology as a transformative vision and practice. These resources are further elaborated in a companion website introduced below at the end of the chapter.

A caution on the multiple meanings of agroecology: from the status quo to a transformative agroecology

Agroecology is being used in different ways and being imbued with different meaning by the wide range of actors (see box) involved in producing publications and other resources (e.g. videos) that highlight aspects of agroecology. Not all of these are compatible with the transformative agroecology supported by many authors of the IAASTD (See Ishii-Eiteman on page 21 in this book). It has been argued that there are multiple 'agroecologies' (Méndez et al., 2013) as it is reinterpreted (Rivera-Ferre 2018) by different actors with different values, intentions and worldviews.

In this chapter, we aim to lift up examples of resources that signal aspects of a transformative agroecology that aims for social justice and sustainability. From this perspective, it is important for agroecology to highlight cases, aspects and dynamics that go beyond techniques and practices (which are also important) to include attention to shifts in political-economic power and questions around agency and control (Nyéléni 2015; De Molina et al. 2019; Video 1).

In contrast, some resources purporting to showcase aspects of agroecology include and promote approaches that maintain power imbalances (e.g. reliance on agribusiness companies) and environmentally harmful practices (e.g. use of synthetic pesticides). These examples are easy to place near the 'status quo' end

Video 1: This film shows voices from different social movements who are acting collectively to articulate a transformative agroecology and to reject both corporate-led industrial agriculture and technocratic meanings of agroecology[1]

of a spectrum that spans status quo to transformative (Figure 1). It is also possible to identify approaches to agroecology that are more "reformist" in nature and that inadvertently or explicitly frame agroecology as a technical approach centered around specific production practices that are clearly void of these transformative elements. These often consider agroecology as one tool in the toolbox rather than a paradigm for transformation. They tend to focus on improved resource efficiency and reduced ecological footprint but give limited attention to the political and social processes that lock in the dominant system and undermine agroecology.

Figure 1: One way to view different representations of agroecology is along a spectrum from status quo to transformative. Any publication or resource should be viewed critically and readers might ask themselves: Who is publishing this and why? What is the underlying message and aspirations of the authors/creators of this resource? To what extent does this resource resonate with a transformative agroecology?

The collective actors authoring agroecology resources

A wide range of actors, institutions, authors, activists and researchers are populating the body of work and producing resources to advance agroecology. The field of agroecology resources is authored by actors positioned within eight primary types:

- Social movements and social movement organizations (e.g. African Food Sovereignty Alliance, International Planning Committee for Food Sovereignty, La Via Campesina)
- Non-governmental organizations (e.g. Pesticide Action Network, Groundswell, Oakland Institute)
- Farmers and social economy businesses
- Philanthropists (e.g. CIDSE, Global Alliance for the Future of Food, Agroecology Fund)
- Researchers and research institutes (e.g. individual authors, SOCLA, IPES-Food)
- Intergovernmental organizations (e.g. FAO)
- Governmental agencies
- Industry (e.g. CropLife[2])

The curated list: seven types of resources

In the following sections, we highlight select examples that we identify as being most exemplary of a transformative agroecology within seven main categories of resources. The resources listed in each category do not comprise a comprehensive, but rather an illustrative, selection of examples.

1. Principles and elements of agroecology

Proponents of agroecology have advanced the idea that agroecology involves a continuous transition that does not follow prescriptive rules, but rather is based on core principles, elements and values that are adapted and applied in particular contexts. Thus, the different proposals for these principles, which are often presented in the form of lists and infographics, are a key resource for anyone looking to engage in agroecology. But, like the growing number of definitions of agroecology, only some of these sets of principles reflect a deeply transformative perspective. Some strong examples include:

- Social Movements: The principles embedded in the Declaration of the International Forum on Agroecology[3] are perhaps the most political and transformative set of principles. They, however, are not packaged into a ready-to-use format in the same way as other principles or elements, and thus, unfortunately, are less accessible.
- CIDSE: Coopération Internationale pour le Développement et la Solidarité presents a framework[4] (Figure 2) that explicitly emphasizes a political dimension, along with the typical social, economic and environmental pillars used to define sustainability.
- FAO: The FAO has generated a widely-used set of 10 'elements' of agroecology, with further details of each element fleshed out in an accompanying report.[5] These elements are impressively social and political for an intergovernmental institution, reflecting the reality that they were created through engagement with civil society in different regions; however, they do not centre political change, reflecting constraints of FAO's political processes.
- HLPE: The 2019 High Level Panel of Experts report on "Agroecological and Other Innovative Approaches",[6] recognizing the deficiency of the FAO's 10 elements in terms of their lack of focus on social agency and human rights, added further elements related to social equity/responsibility.
- Biovision and Gliessman: The Agroecology Criteria Tool[7] combines Steve Gliessman's commonly used five levels of transition[8] with the FAO's 10 elements to create a tool for evaluating the extent to which agroecology's multiple dimensions are being satisfied. Biovision attempted to interpret these elements and levels for the purpose of evaluation.

Figure 2: CIDSE's principles and facets of agroecology presented here in infographic form.

2. Practices/case studies

A growing number of case studies at the farm, community or regional level provide either examples of agroecological practices or of how specific areas have made a transition to agroecology. These were often generated to demonstrate that producers are using agroecology now and that, when undertaken in an enabling environment, agroecology can provide multiple benefits and outcomes. They are intended to inspire and inform. Many of these case studies include concrete descriptions of locally adapted agroecology on farms or in territories, highlighting markets, the integration of appropriate technologies, biological or collective approaches to pest-control, women-led efforts or other dimensions of agroecology. The most powerful case studies in this category provide examples of a particular practice (e.g. water harvesting), while also discussing the political dimensions of the issue and practice and including voices of practitioners themselves – especially non-dominant perspectives (such as women, youth, lower caste, indigenous, etc.). This resource type often includes pictures, diagrams or film/videos.

• AFSA: The African Food Sovereignty Alliance and the Oakland Institute provide an excellent set of regionally specific case studies[9] (Figure 3) of agroecology featuring a blend of examples that combine practical and political considerations.
• La Revuelta Al Campo: The "Revolt in the Fields" project website[10] has a series of agroecology related videos from examples in Spain.

• Why Hunger: Agroecology: Putting Food Sovereignty into Action[11] provides a strong political contextualization of the need for food sovereignty before presenting nine place-based discussions of agroecology by social movement actors from around the world. This publication is heavy on the political aspects; but a reader looking to learn from practical case studies would be better served by looking elsewhere.
• TransformAfrica: The series of videos, Women and Agroecology in Africa, highlight agroecology from the perspective of women, combining the practical with issues of equity.[12]
• ALISEA: The Agro-ecology Learning Alliance in Southeast Asia[13] (ALISEA) has a searchable database including case studies and factsheets about initiatives with many practical case studies.

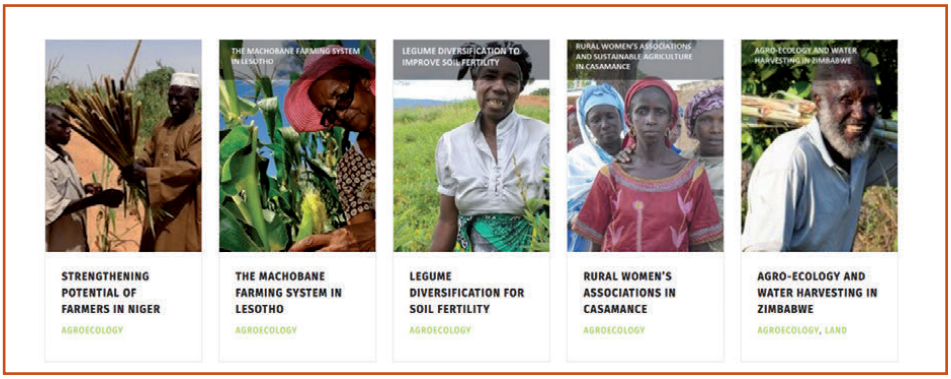

Figure 3: A screenshot of agroecology practice case studies at the African Food Sovereignty Alliances Website.

3. Policies

The relationship between policy and agroecology is complex (see: Giraldo and McCune 2019); therefore, any simple list of policies that support agroecology is a risky oversimplification without an explanation of the context. Further, some lists of policies for agroecology have inclusion criteria that are quite open and not subject to vetting against principles of agroecology. Thus, many of the policies indicated may just as easily support corporate-led, climate-smart or even conventional agriculture. With this in mind, some attempts have been made to collect and present policies that promote agroecology. For example:

• Latin America Report: The report, "Public policies to support agroecology in Latin America and the Caribbean"[14] not only lists a set of policies that support agroecology, but also discusses their emergence and history and takes more of a critical perspective.
• FAO's AgroecologyLex: The AgroecologyLex[15] is a continually updated online database of legal frameworks, policies and programmes related to agroecology in different national contexts. For each entry, users are able to access a summary

of the policy, focusing on the "purpose and specific objectives, institutional frameworks and main forms of support."

• ALISEA Library of Policy Documents: The ALISEA online library[16] lists a range of documents related to agroecology policy – many of which are excellent resources not just for the Southeast Asia region but for anyone interested in policy.

4. Agroecology learning and training

Given the new attention to agroecology, many people are creating formal and informal learning opportunities in the form of courses, workshops, learning exchanges, peer-to-peer informal learning programs, series of field-based classes, or entire degree programs. Some of these seem to be a re-naming of existing training as "agroecology" rather than a genuine re-focusing. For example, a large Midwestern US university includes courses in Basic Golf Club Design and Repair and Introduction to Turfgrass Management in its "Agroecology Specialization". A transformative agroecology implies a particular approach to learning and pedagogy, most commonly found in programs with social movement backing, and include for example a political analysis, horizontal methods of learning and a dialogue of different ways of knowing. A growing body of literature has highlighted the characteristics of a transformative approach to agroecology learning (La Via Campesina 2017; Rosset et al. 2019; Anderson et al. 2019a, b, c).

Figure 4: Learners from Mali, Morocco and Italy at Schola Campesina's international course on Global Governance.

Learning rooted in informal and social movement settings:

• La Via Campesina sponsors a set of peasant universities and programs[17] around the world that root the practice of agroecology in a deeply political analysis.

• European programs affiliated with the European branch of La Via Campesina are highlighted in the European Agroecology Knowledge Exchange Network[18] (EAKEN).

• Schola Campesina (Figure 4) is an international agroecology school seeking to share, valorise and develop knowledge on agroecology and global governance of food and agriculture and offer in-person courses and workshops as well as a Schola Campesina online course on global governance of food.

• Escuela Campesina Multimedia presents videos and resources in four languages on the Peasant-to-Peasant learning methodology.[19]

• International People's Agroecology Multiversity involves a research-learning-action approach to agroecology that puts agroecology in the framework of food sovereignty, ecological and social justice. It is coordinated by a network of farmers and women's organizations, NGOs, researchers and academic institutions.[20]

Figure 5: Agroecología Map (Brazil)

Learning rooted in formal settings at universities and colleges:

• The Agriculture, Food & Human Values Society[21] and Sustainable Agriculture Education Association[22] maintain lists of educational programs in the U.S. and Canada, which can be searched for "agroecology".

• Universities in the Netherlands, France, Norway, Spain and other EU countries offer individual and shared programs listed through the European Network of Organic Agriculture Students[23,] the European Master in Organic Agriculture and Food Systems[24] and Agroecology Europe[25].

• In Latin America, one place to find University Programs is through the Red de Programas de Agroecología de Latinoamérica / Red-PAL – an initiative set to enable cooperation, exchange, research, and the training amongst universities engaged in agroecology.

• A number of "massive open online courses" (MOOCs) on agroecology exist, including, for example one based in Argentina.

5. Agroecology mapping initiatives

Organizations and networks are creating online maps of agroecological farms, markets, crop varieties and livestock breeds, soil fertility and water management practices, policies and more. Mapping initiatives respond to a desire to document, better understand and make visible the rapid emergence and evolution of agroecology and to understand where nodes of activity or vacuums exist – or simply to find good projects in a particular area. A recent guide, Mapping for Food System Change[26], highlights the issues, challenges and emerging opportunities that might arise when designing mapping processes to support food system change. Maps often have loose criteria for inclusion and might include initiatives that do not align well with agroecology, so users should examine the criteria and transparency of the map and not take for granted that everything matches with a transformative agroecology. Some examples of maps include:

• The open source Agroecology Map[27], based in Brazil (Figure 5), aims to help bring urban and rural people together to create and strengthen collaborative networks to exchange experiences and strengthen agroecology.
• Other maps are not specifically focused on agroecology *per se*, but are built around key dynamics and initiatives in a transformative agroecology. The Community Seed Map[28], for example, maps people and programs working on seed saving and sharing. The Open Food Network[29] is an online platform and global open source community where producers, stores, consumer groups, etc. can join and be listed on the map to connect in local/territorial food systems.

6. Books and longer academic treatments

Scholars and activists have been writing influential books and reports on agroecology for at least 60 years (not to mention the generations of scholarship and knowledge that agroecology research builds on), reflecting a substantial resource for those looking for in-depth treatments of agroecology. This section highlights a selection of recent relevant edited or single-authored academic work and project websites. Google Scholar[30] searches for "agroecology" and related terms is a great way to explore the wider literature. Although much academic work requires a subscription or exorbitant fees to access single articles, a request to the author will usually result in a copy. Most researchers are eager to share their work with those who are not able to access it otherwise.

• Key texts on Political Agroecology and Transitions: Examples include Political Agroecology: Advancing the Transition to Sustainable Food Systems[31] by Manuel González de Molina and co-authors, and Agroecology: Science & Politics[32] by Peter Rosset and Miguel Altieri. A bibliography of articles related to agroecology transition[33] was produced by the AgroecologyNow! Group at the Centre for Agroecology, Water and Resilience and features many relevant articles for a transformative agroecology. Recent special issues in the Journal of Agroecology and Sustainable Food Systems focus on scaling agroecology[34] and agroecology transformations.[35]
• HLPE Report: Although it does not emphasize transformative agroecology as the term is used here, the report on "Agroecological and Other Innovative Approaches…"[36] by the High-Level Panel of Experts of the United Nations Committee on World Food Security devoted considerable space to the transition to agroecology and more sustainable food systems. Table 4 on page 63 of that report demonstrates clearly that systems that the authors associate with agroecology (organic agriculture, agroforestry, permaculture and food sovereignty) have superior outcomes for food security and nutrition.
• Academic Societies: Several academic societies offer regular conferences or newsletters that contain information about agroecological research that may not be written up in books or journal articles yet. These include: The Latin American Scientific Society for Agroecology SOCLA[37], The Agroecology Research Action Collective (ARC)[38] in the US and Agroecology Europe[39].
• Research Project Websites: Many projects of different scales have generated websites that focus on particular topics related to agroecology. For example,

the "SECuRE Project"[40] focuses on soil ecological function restoration to enhance agroecosystem services in rainfed rice cropping systems in agroecological transition.

7. Subscription based resources: blogs, newsletters and magazines

Readers can subscribe to a number of different blogs, newsletters and magazines that focus specifically on agroecology. These often share notices related to the other resource types (e.g. case studies, policy analysis, courses) as well as original analysis, commentary and other items.

• Farming Matters[41] (Figure 6) was published by ILEIA in multiple languages over the last two decades and – particularly in the last five years – focused on the political and social as well as the practical dimensions of agroecology. Back-issues and recent special issues on agroecology are great resources, archived online.

• The Nyeleni Newsletter[42] is pitched as, "the voice of the international movement for Food Sovereignty" and aims to strengthen "the grassroots of the movement", by providing accessible material on key issues. Most of the back-issues are available online and have articles that speak directly to agroecology.

• Revista Soberanía Alimentaria[43] is a Spanish language website that focuses on food sovereignty, biodiversity and cultures.

• FAO's agroecology newsletter[44] shares information on upcoming events, publications and other news regarding FAO's work on agroecology and also other items from the wider global field of agroecology.

• Regional or nationally focused subscription-based resources include, in Latin America, the magazine Biodiversidad[45], which combines the practical and the political, emphasizing the link between those who work to "manage biodiversity" with cultural diversity and self-government, especially local communities: indigenous and African-American women and men, peasants, fishermen and small producers. In the European context, ARC2020[46] provides a monthly newsletter on agri-food, rural issues, environmental policy and practices around Europe. In the US context, Civil Eats[47] provides agroecology-tagged articles in a journalist style that often speaks to scientific, social and political issues.

Figure 6: Farming Matters magazine provides many important practical case studies of agroecology.

Concluding thoughts

The growing body of rich and diverse publications and resources is indicative of a robust effort to advance a politically-rooted agroecology as a transformative paradigm for social justice and sustainability in food systems. Yet, it is important to think critically about the resources available, as many of these are framing agroecology in subtle ways that can redefine its meaning, reduce the political dimensions and serve to co-opt agroecology to reinforce the status quo.

The recent uptake of agroecology, including by institutions like the FAO and some national governments, has led to a backlash with agroecology as the object of fierce attacks and confrontations. These interventions are directly obstructing agroecology (e.g. blocking policy) and also serve to confuse policy-makers and citizens so that they cannot distinguish easily among different pathways. This division mirrors the stark divide in the international arena between actors intent on preserving extractive food systems that focus on profit-making and exploitative practices versus those seeking equitable, sustainable and democratic food systems.

While many of the publications and sources reviewed here are excellent resources, it is also important to point out that many of the sources of information and inspiration for agroecology are embedded in local practices that have not been documented at all, even though they may be powerfully transformative for local actors. Local actors may not refer to their work as agroecology; therefore, it is important to connect with and learn about the kinds of political and practical work on food systems that people are doing with their hearts, heads and hands in each locale. It is also important to remember that different kinds of organizations, institutions and authors have vastly uneven funding and power to produce these publications, with former colonial governments holding most of the money and doling it out very selectively based on their own interests. This means that organizations with deep pockets such as corporations and FAO can produce slick products with wide marketing reach that often overshadow grassroots movements and local voices.

In order to deepen the agroecological perspective, readers should consider putting their practices and views on agroecology into conversation with complementary fields that can help to enrich the political understandings and dimensions of agroecology. Readers are invited to connect with the wide body of thinking, scholarship and action in fields such as decoloniality, solidarity and sharing economies, feminism, degrowth and post-development alternatives. These approaches can help to expand the horizons and challenge the assumptions of those advancing agroecology by viewing the world through feminist, anti-capitalist, decolonial, post-developmental, non-Western and other lenses (see Gonzales & Mignolo on page 157 in this book). Linking agroecology to these wider struggles to transform the powerful cultures and structures that oppress and subvert emerging alternatives can build momentum for the deep processes of transformation needed to build a more just and sustainable world. This guide presents only a snapshot in time. The field of agroecology resources is constantly growing and there will be both resources we have missed and ones that are yet to come, in different languages and from a wider range of sources.

We invite readers to visit and contribute to **www.AgroecologyCompass.net** where the authors offer an evolving webspace with a more in-depth curated guide and a more comprehensive database.

Endnotes

1 available in EN, ES and FR, http://www.agroecologynow.com/video/ag/
2 CropLife, an organization that represents biotechnology industry, have created an infographic, webpage and quiz on agroecology and is one of the most glaring example of co-optation. Their construction of agroecology clearly advances corporate interests, redefines agroecology so it is open for indiscriminate use of chemicals and violates many of the principles of agroecology.
3 https://www.foodsovereignty.org/wp-content/uploads/2015/02/Declaration-of-the-International-Forum-for-Agroecology-Nyeleni-2015.pdf
4 https://www.cidse.org/wp-content/uploads/2018/04/EN_The_Principles_of_Agroecology_CIDSE_2018.pdf
5 http://www.fao.org/3/i9037en/i9037en.pdf
6 http://www.fao.org/3/ca5602en/ca5602en.pdf
7 https://www.agroecology-pool.org/methodology/
8 https://www.tandfonline.com/doi/full/10.1080/21683565.2015.1130765
9 https://afsafrica.org/case-studies-agroecology/
10 https://larevueltaalcampo.wordpress.com/
11 https://whyhunger.org/images/agro/agroecology-putting-food-sovereignty-in-action.pdf
12 https://ma.boell.org/fr/2018/11/29/femmes-et-agro-ecologie-en-afrique
13 https://ali-sea.org/online-library/
14 https://infoagro.net/sites/default/files/2018-06/Persp45_Sabourin_ENG.pdf
15 http://www.fao.org/agroecology/policies-legislations/en/
16 https://ali-sea.org/online-library/
17 https://viacampesina.org/en/schools/
18 https://www.eurovia.org/eaken/
19 https://agroecologia.espora.org
20 https://ipam-global.org
21 https://afhvs.wildapricot.org/Degree-programs
22 http://www.sustainableaged.org/projects/degree-programs/
23 http://www.enoas.org/index.php?page=7
24 https://www.eur-organic.eu/en/79292
25 https://www.agroecology-europe.org/study-train/study-programme-der/
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47 https://civileats.com/category/farming/agroecology/

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Foundation on Future Farming

Global agriculture on 2000 square meters in Berlin. © Volker Gehrmann

The Foundation on Future Farming, based in Bochum Germany, is a charitable foundation promoting agroecological and organic innovation in agriculture. It's focus is on maintaining and developing the diversity, free reproducibility and regional and local adaptation of seed. Based upon these principles, organic breeders create new varieties serving the needs of modern organic farming. In addition, the Foundation supports on-farm educational measures, research and publications as well as non-profit activities of small farmers and NGOs.

The Foundation's Berlin office engages in networking and campaigning on global, European and German agricultural policies, including the use of new technologies and their control. Since ten years, it maintains a bi-lingual website on the original IAASTD report and subsequent publications. In addition, the Foundation runs an educational field of 2000 square meters in Berlin, symbolizing the individual share of the world's citizens (7,5 billion) in the total cropland of this planet (1,5 billion hectare). The field conveys a sensual experience „my 2000 square meters", especially to young people and families of, adding in depth information and suggestions about their personal impact on agricultural and food systems, including climate change, biodiversity, soil erosion and fair and equitable food production and prices.

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ISBN 978-3-00-066209-6