

IAF

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FOOD AND WATER SECURITY

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This issue of International Affairs Forum focuses on the dual themes of Food Security and Water Security. Both interrelated and topical, our topics this issue have warranted continued interest as the global population increases and is projected to continue to do so dramatically over the next ten to fifty years. With such projections for human habitation, many wonder how to not just sustain life, but to improve the quality of life for the millions who struggle on a daily basis. These topics of food and water security, linked to larger issues of sustainability and conflict, have been the focus of mainstream news outlets as well as numerous academic forums and publications. Many of discussions in these various forms have focused on the question of “what next?” And “what can be done to move countries and people from food and water insecurity to being secure?

To this end, our contributors to this issue add their thought-provoking commentary to the growing discussion to-date about water and food security. The pieces included in this issue range from short essays and research notes, opinion-editorials, and interviews with practitioners, academics, and affected parties discussing the complexities of water and food security. Their contributions provide us with new perspectives on these issues, challenge us to re-think current trends and understandings about “winners” and “losers” in the securing of food and water, as well as provoke us to reconsider we [humans as a whole] understand our relationship to livestock animals, agriculture, wastage, and land degradation globally.

The pieces range from arguments about the necessity for changes to the global food system to deal with the multiple issues within the umbrella of “food security” (Benton), to an interview discussion about the impact global food insecurity has on national security for states like the U.S.A. (Flowers). Other short essays and op-ed pieces further address this issue of food security/insecurity, examining emerging diseases of food animals (Roth and Galyon), and how rural-urban convergence impacts food availability and production (Fanzo). The inclusion of two pieces (one an interview – Munang; and the other a short research note – Ambuko) specifically addressing the African continent in relation to food security and related issues, provide interesting insights into the need for a multi-faceted approach to overcome food insecurity in Africa, highlighting an approach which, championed by many of our contributors, is one that is pertinent equally to other parts of the world. Chartres provides a thought-provoking look at the water-food sustainability nexus, and how it is not always about the lack of viable solutions available, but that the issue at its heart is about the political will to change the status quo.

Building on discussion about the water-food sustainability nexus, the next pieces continue on this general theme – discussing in an interview, the ways to improve water sustainability (Sarni) as well as the light-heartedly titled piece “Please make avocados sustainable again!” (Häberli) that challenges us to re-think about what we eat, as some foods are “neither ecologically nor socially sustainable.” The final two contributions take a broader look at our themes: the first of these provides insights into how water management can be seen in terms of conflict management of a vital resource (Wolf) and how despite trends to consider this as a cause of cross-border tensions, in more cases it is the cause of tensions within countries rather than

between. In our final contribution to this issue, Professor Bürgi Bonanomi discusses in an interview how there are always trade-offs in sustainable development, but that governance in this area should “focus on resolving conflict of interests between different regimes [economic, social, environmental policy areas].”

Collectively, the mix of interviews, short essays, and op-ed pieces in this issue represent a cross-section of the interesting work taking place on this topical subject; adding to the discussions and debates occurring at a policy-decision-making level, but also discussions happening at the civil society level across countries globally. The contributions here have stretched thinking about food and water insecurity, not only to ensure that there is security in these areas. The outlook may seem bleak in some ways for tackling insecurity, but our contributors have also raised hope and expectations about how governments, and people, need to consider more, the linkage between food-water-animals-agriculture-population growth-degradation of resources-economic cycle we are in, to find more holistic solutions that will move us [all of us collectively] globally, beyond the current status quo..

The editorial team hopes the current collection in this issue provides you with further thought and new perspectives to the ongoing debates about food and water security/insecurity taking place in different corners of the globe.

There have been changes to the publication in the past several years, and the most recent ones provide the editorial team a new opportunity to reflect on our aims for the International Affairs Forum and to establish its position in relation to other outlets in the field of international relations and current affairs. The current issue demonstrates the publication’s unique place within the field, providing an outlet for academic-type research and discussion articles, short essays, and opinion-editorial pieces from researchers and practitioners, alongside International Affairs Forum interviews with scholars and officials (from think tanks, international organizations, and academic institutions) who assist with informing and shaping the policy-making landscape.

The core values for the publication are:

- We aim to publish a range of op-ed pieces, interviews, and short essays, alongside longer research and discussion articles that make a significant contribution to debates and offer wider insights on topics within the field;
- We aim to publish content spanning the mainstream political spectrum and from around the world;
- We aim to provide a platform where high quality student essays are published (winners of the IA Forum Student Writing Competition);
- We aim to provide submitting authors with feedback to help develop and strengthen their manuscripts for future consideration.

All of the solicited pieces have been subject to a process of editorial oversight, proofreading, and publisher’s preparation, as with other similar publications of its kind.

We hope you enjoy this issue and encourage feedback about it, as it relates to a specific piece or as a whole. Please send your comments to: editor@ia-forum.org

DISCLAIMER

International Affairs Forum is a non-partisan publication that spans mainstream political views. Contributors express views independently and individually. The thoughts and opinions expressed by one do not necessarily reflect the views of all, or any, of the other contributors.

The thoughts and opinions expressed are those of the contributor alone and do not necessarily reflect the views of their employers, the Center for International Relations, its funders, or staff.

Transforming the Food System

Professor Tim Benton
University of Leeds, United Kingdom

Since the 1960s, global agricultural output has risen enormously. The global population between 1961 and 2016 increased 142%, yet cereal yields outpaced population growth by 193%, and overall calorie production rose by 217%. This rise largely came from advancements in technical efficiency considering arable land increased by only about 10% in the same time interval. This increase in supply-side efficiency increased per capita availability of foodstuffs, and reduced its average price, with a real term decline in the World Bank food price index by about 37%.

This apparent success story is based on three main pillars - investing in productivity growth through supporting research and innovation; stimulating and supporting farm sectors through various measures, like subsidies; and liberalizing trade. Countries built on natural endowments of soil, water, climate, and land, could maximize their comparative advantage and be enormously productive and profitable by growing commodity crops.

This, in turn, have led to global agriculture becoming increasingly focused on a few highly productive commodity crops suited to industrial farming systems and grown at scale in the “breadbasket” areas of the world. Over 50% of the world’s crop calories come from wheat, rice and maize; and, in total, over three quarters comes from wheat, rice, maize plus sugar, barley, soy, palm and potato. These staples have crowded out other, more “traditional” varieties of crops, and has also attracted the majority of crop-related R&D.

The majority of the world’s production comes from a small number of crops grown globally which has led to a convergence of global diets built upon them. Furthermore, calories are relatively freely available for the majority of people. As yields have grown and prices declined, the prevalence of obesity has increased, and increased in an accelerating way. Furthermore, as food becomes cheaper, it is, for many, economically rational to waste it. Waste, like obesity, increases with agricultural productivity in an expedited way.

A focus on productivity also means there are incentives not to farm sustainably if such methods reduce yields in the short term. Around the world, soils are degraded, air and

From a climate change perspective, the food system is a major driver of climate change.

water polluted, biodiversity lost, and greenhouse gases emitted with gusto in the name of making food cheaper and more available.

The externalized costs from agriculture onto planetary and human health far exceeds the economic value added from agricultural productivity. Just one non-communicable disease related to obesity, diabetes, has close to 700 million sufferers globally. Even if treated on average at a quarter of diabetics' costs in the U.S., the global cost of the disease would exceed the total agricultural GDP. The rapid increase in global malnutrition in all its forms is becoming a major determinant of ill health and is immensely costly, both personally and economically.

From a climate change perspective, the food system is a major driver of climate change. Of food's emissions, about half is related to global livestock. The growth of the sector is underpinned by the increasing ability to feed livestock cheap grain to make cheap meat. Evidence is now suggesting the only feasible way to manage climate change close to the Paris Agreement's goals is if humans change diets, which would reduce air emissions and pressures on land.

Luckily, if we need to change diets for public health reasons and environmental reasons, there is a significant overlap of what change would contribute to solutions. Eating less, eating more fruit and vegetables, less meat, especially red and processed meat, and less highly refined grains and sugar would contribute to both preventative health care and planetary health.

The issue is how would we get there? The "productivity-led, cheaper food is better" paradigm is deeply entrenched in society for a variety of reasons. Internalizing the external costs to make diets healthier and more sustainable implies producing less, but better quality food, with profits for actors coming from selling less for more. Many argue that such price rises would be regressive, but we need to find ways of supporting equal access for food without driving the food system to subsidize food prices in the name of "food poverty" from health and environmental systems. We need to tackle poverty not to further normalize health-wrecking and planetary-wrecking diets to avoid tackling the real inequality.

Without a transformation in the food system, we're simply accelerating the costs of health

and environmental damage, accumulating more each generation. In the long run, our current food system is unsustainable. We need to tackle the root causes with urgency.



Professor Tim Benton is Distinguished Visiting Fellow in the Energy, Environment and Resources Department at Chatham House. He is also Dean of Strategic Research Initiatives at the University of Leeds. From 2011 to 2016 he was the ‘champion’ of the UK’s Global Food Security (GFS) programme, a multi-agency partnership of the UK’s public bodies (government departments, devolved governments and research councils) with an interest in the challenges around food. The key role of GFS was to undertake systemic analysis and horizon scanning, in order to identify priorities to mitigate the challenges of providing sufficient, sustainable and nutritious diets for all. He has published over 150 academic papers, most tackling the core themes of agriculture’s environmental impact and more generally how systems respond to environmental change. He is a frequent contributor to events around the world.

U.S. and International Food Security Policies

Interview with Kimberly Flowers

Center for Strategic and International Studies, United States

What do you view as the major global challenges to address food insecurity issues?

While there is a myriad of drivers responsible for rising global hunger trends, the most pressing concerns to me are climate change and armed conflicts. As access to vital resources become more and more stressed, such as potable water and quality soil, competition amongst communities and countries for natural resources will increase. Tragically, vulnerable populations most acutely feel the damages of droughts, floods, and pests and diseases. In Nigeria, a changing climate has forced pastoralists to change their migration patterns, leading to violent conflicts between pastoralists and farmers. Lack of leadership and good governance only stokes the climate change fire that is bound to incinerate progress towards food security in fragile contexts.

Sixty percent of the world's hungry live in countries affected by conflict. Starvation is used as a method of warfare. Food shortages can spark unrest. The Sustainable Development Goal of ending hunger will not be achieved until there is peace. Last year, the United Nations Security Council passed a historic resolution recognizing the link between hunger and conflict. Until we can end man-made conflicts, there will continue to be serious

food insecurities and inequalities in the world.

How does global food insecurity affect U.S. national security interests?

Linkages between global food security, political stability, and economic prosperity have been well established, from the urban food price riots in 2007/2008 to the connections today between protracted conflicts and potential famines. The U.S. intelligence community has recognized the threat that global food insecurity places on U.S. national security interests. As stated in the 2015 Intelligence Community Assessment on Global Food Security, "in some countries, declining food security will almost certainly contribute to social disruptions or large-scale political instability or conflict, amplifying global concerns about the availability of food." U.S. military and political leaders alike have been vocal about the role that foreign assistance plays in the cost-effective prevention of further chaos, especially as it relates to the nexus between food insecurity and instability.

These points were highlighted in a recent CSIS report on [*Risk and Resilience*](#) in Nigeria. Stakeholders on the ground told us that youth are more vulnerable to joining insurgent groups when experiencing food insecurity. Africa has the youngest population in the world, with almost 200

million people between the ages of 15 and 24, a number that is likely to double by 2045. Youth make up the bulk of the unemployed in Nigeria, and opportunities offered by insurgency groups are tempting to young people whose families don't have access to basic needs. Such a reality is particularly worrisome in fragile states where one in two youths who join rebel movements cite unemployment as a key motivation. Creating economic opportunities for vulnerable communities can reverse this trend, and it is in the interest of the United States to invest in strategies and programs that support youth empowerment, good governance, and food security.

Are current U.S. leadership and policies adequately addressing global food security issues? What, if anything, would you like to see in policies not currently in place?

The United States has invested nearly \$1 billion a year to address global hunger, poverty, and malnutrition since the launch of its global hunger and food security initiative, Feed the Future, in 2010. The results from concentrating strategies and funding in select focus countries reaped impressive returns. From 2010 to 2017, inclusive agricultural growth and nutrition programming decreased poverty by 23 percent and stunting by 32 percent in areas where Feed the Future operated.

From a policy perspective, food security has bipartisan support in Congress, proven by the passage and reauthorization of the Global Food Security Act, which provides the framework for U.S. support for food security in key countries around the world.

Current U.S. policies are in place with a sound strategy that appropriately prioritizes resilience, water and sanitation, and private sector engagement. The question is not what needs to be changed about the current policies in terms of foreign assistance programming, but rather the challenge is for Congress, U.S. agencies, and the many implementing partners to ensure effective implementation.

While the Trump Administration has proposed cuts to foreign aid and failed to strengthen global food security efforts within the State Department, make significant commitments at global summits, or prioritize discussions within the National Security Council, the United States remains a global leader thanks to policies created before this administration, Congressional champions on both sides of the aisles, and dedicated U.S. civil servants who understand the value of investing in global food security.

But we can always do better. More should be invested in nutrition, which receives less than 0.003 percent of the total U.S. federal budget despite a strong return on investment and clear linkages to economic growth. Policy makers should also raise the profile of global food security within U.S. diplomatic and national security strategies. Global food security deserves greater prominence within foreign policy debates and demands better coordination between development, diplomacy, and defense sectors.

FAO states that “women produce between 60 and 80 per cent of the food for most developing countries and are responsible for half of the world’s food

Due to enforced gender roles and norms, most women do not have equal access to education, land rights, or financial services, to name a few.

production.” What special challenges and constraints do women face regarding food production - and the food system?

While female farmers are the key to success in food security and agricultural development, they face substantial obstacles. Due to enforced gender roles and norms, most women do not have equal access to education, land rights, or financial services, to name a few. Even if women are employed, they earn lower wages than men. These barriers to entry and growth are significant, as most smallholder farmers are women, and, as urbanization creates job opportunities in nearby cities, women will be responsible for productive plots of land while men take advantage of economic opportunities nearby. If women had greater access to quality inputs, information, and financial services, coupled with greater empowerment to participate equally in the formal economy, we could feed 150 million more people.

What food-related technological innovations do you think have the greatest potential to make positive impacts?

There are two technological innovations that come to mind: biofortification and gene-editing. Biofortification enables scientists

to fortify staple crops with micronutrients to address hidden hunger issues. For example, young children in households producing and eating biofortified orange-fleshed sweet potato in a province in Mozambique have seen a 15 percent decrease in vitamin A deficiency.

Gene-editing technology like CRISPR allows scientists to improve staple crops and seeds, while also making other horticulture crops more easily grown in climate-stressed regions. The challenge to both biofortification and CRISPR is dispelling misinformation (i.e. neither of these scientific breakthroughs are GMO-related) and scaling them up to enhance global food security.



Kimberly Flowers is director of the Global Food Security Project and the Humanitarian Agenda at CSIS. The Global Food Security Project examines and highlights the impact of food security on U.S. strategic global interests and provides long-term, strategic guidance to policymakers to ensure that U.S. foreign assistance programs are efficient, effective, and sustainable. The Humanitarian Agenda is an initiative that leverages the expertise of CSIS programs to explore the most complex humanitarian challenges of the twenty-first century.

Prior to joining CSIS in 2015, Ms. Flowers was the communications director for Fintrac, an international development company focusing on hunger eradication and poverty alleviation through agricultural solutions. From 2005 to 2011, she worked for the U.S. Agency for International Development, serving overseas as a development, outreach, and communications officer in Ethiopia and Jamaica, supporting public affairs in Haiti after the 2010 earthquake, and leading strategic communications for the U.S. government's global hunger and nutrition initiative, Feed the Future. Ms. Flowers began her international development career in 1999 as a Peace Corps volunteer in Bulgaria, where she founded a young women's leadership camp that continues today. She also served as a Peace Corps Response volunteer in Jamaica in 2004. She is a magna cum laude graduate of William Jewell College, studied at Oxford University, and is an alumna of the Pryor Center for Leadership Development.

Emerging Diseases of Food Animals Threaten Global Food Security

Professor Jim Roth and Jane Galyon
Center for Food Security and Public Health
Iowa State University, United States

The global human population has grown from 2.4 billion in 1950 to 7.3 billion in 2015. World population is expected to reach 9.8 billion people in 2050. This growth has led to a corresponding growth in the production of food-producing animals to support human nutrition (Figure 1).

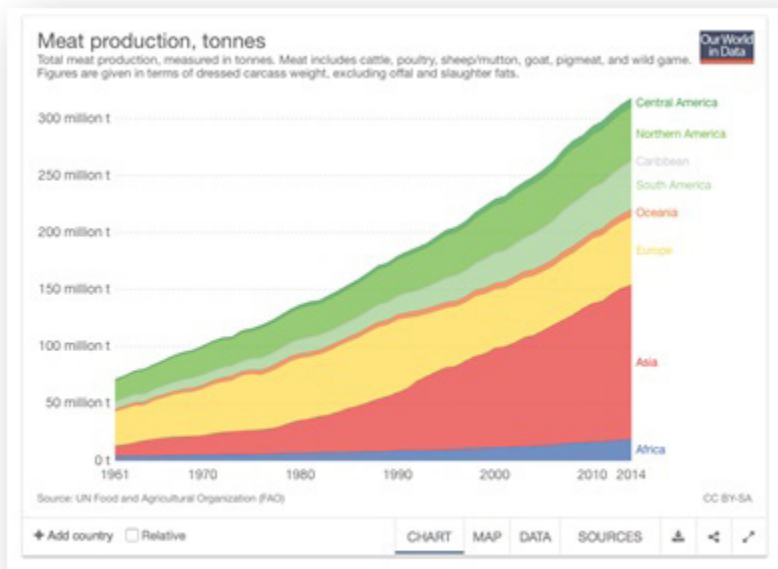


Figure 1

A consequence of this rising population of food-producing animals is an increase in the emergence and reemergence of animal diseases. Dense populations of animals allow diseases to rapidly spread and provide opportunities for disease agent mutation and adaptation to a new species or increased disease severity. Animal-based food production has already increased dramatically since 1963. Much of the increase in meat production has occurred in Asia. The United Nations Food and Agriculture Organization (UN FAO) estimates that food production needs to increase by approximately 70% from 2005 to 2050 (Figure 2). Continuing to increase production of animal-based protein so that the human population can continue with a similar diet will be a challenge.

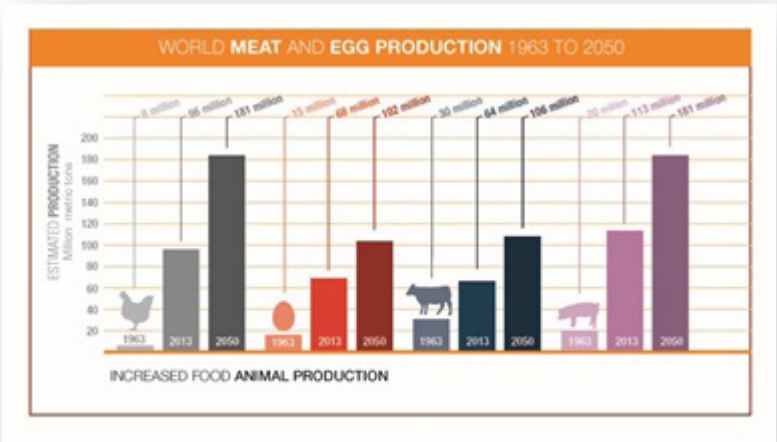


Figure 2

FAO: Food Production Needs to Increase 70% from 2005/07 to 2050

Emerging diseases include previously unknown diseases that may occur and spread, well-known diseases that occur in areas where they have never been seen before, and diseases that had been controlled that reemerge. There are a number of known emerging diseases of food animals that threaten food security (Figure 3).

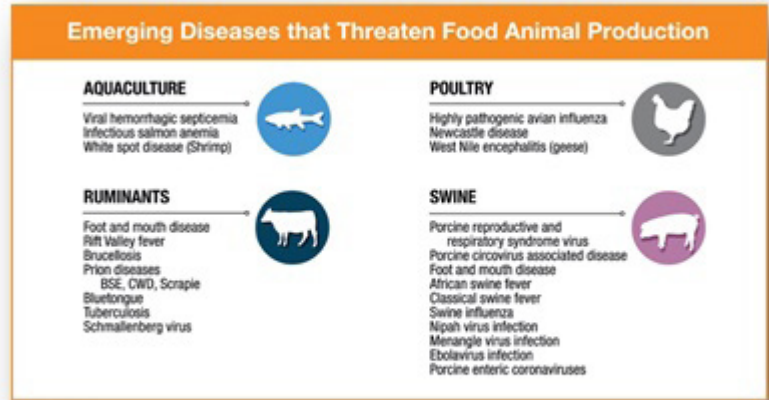


Figure 3

Diseases may emerge due to a variety of factors. These factors are largely driven by the rapidly increasing human population which requires increased livestock, poultry and aquatic animal-based protein. The resources required by the increasing human and animal population leads to environmental degradation and climate change. This results

There are a number of known emerging diseases of food animals that threaten food security

in increased interactions between wildlife, domestic animals and humans and can lead to inter-species transfer of pathogens and emergence of new diseases. International trade and travel also facilitate the spread of diseases for both humans and animals.

Two different production systems are predominantly used to increase animal-based protein production for human consumption: Intensive animal agriculture and “backyard” animal production. Both have advantages and disadvantages. Intensive animal agriculture, sometimes referred to as *concentrated animal feeding operations* (CAFOs) involves very large operations. These operations efficiently produce high-quality animal proteins at reduced costs. Industrialized egg laying facilities may have several million laying hens on one site and feedlots may have over 80,000 head of cattle. Dairies may have greater than 5,000 lactating cows, and swine farms may have over 20,000 animals. These sites typically have very good management, nutritional support, and veterinary care. Swine and poultry operations with indoor housed animals typically have good biosecurity to help prevent disease incursion. However, should a pathogen enter the facility, transmission may rapidly spread due to the high concentration of animals on the site. In addition, the pathogen could mutate and adapt to the host. Intensive animal production operations are often located close together, facilitating disease spread between sites. Diseases that can be devastating in intensive poultry and livestock production systems include highly pathogenic avian influenza, African swine fever, classical swine fever, and foot and mouth disease. Intensive agriculture operations may also present concerns regarding animal welfare and environmental preservation.

The 2015 H5N2 avian influenza outbreak in the U.S. is an example of how an emerging infectious disease can impact intensive operations. In the State of Iowa 31.5 million poultry died or were euthanized in a two month period due to the outbreak, the vast majority being in large commercial operations. Fortunately, the disease was not zoonotic (definition: diseases caused by infections that spread between animals and people) and was brought under control and eradicated before it spread further.

Backyard animal production is primarily used for poultry, swine, and small ruminants in both urban and rural areas and can also lead to increased disease emergence. These small operations efficiently reuse household waste for feed, require no transportation, and are a very important source of dietary protein and income for families and smallholder farmers in many countries. However, the close interaction between people and their food-producing animals increases the risk of zoonotic disease transfer to humans. These animals rarely

have any veterinary care or receive vaccinations and there is almost no biosecurity to inhibit disease transmission. Diseases can spread rapidly between these animals. Disease outbreaks in backyard animals can also have serious dietary and income consequences for the owners and local community.

Intensive aquaculture involves fin fish, crustaceans and mollusks. Aquaculture is the fastest growing area of animal protein production. This is largely because capture fisheries in oceans and inland waterways are becoming depleted. Fish provide more than 3.1 billion people with almost 20% of average per capita intake of animal protein. An advantage of aquaculture is that a high quality product can be efficiently produced and that pressure on wild fish stocks can be reduced. However, aquaculture can deplete low value wild fish captured as food for carnivorous farmed fish such as salmon. Aquaculture typically uses very high stocking densities in outdoor ponds, indoor confined tanks, or in large nets in the ocean. These production systems have varying degrees of biosecurity for disease exclusion. A consequence of high stocking densities in aquaculture, similar to livestock and poultry production, is that if diseases are introduced they can multiply and spread rapidly with devastating consequences. Disease problems that have emerged in aquaculture systems include sea lice in salmon, infectious salmon anemia, viral hemorrhagic septicemia of various species of marine and fresh water fish, and white spot disease of shrimp. If aquatic animals are raised in nets in the ocean or lakes, parasites and diseases can spread and impact the wild population.

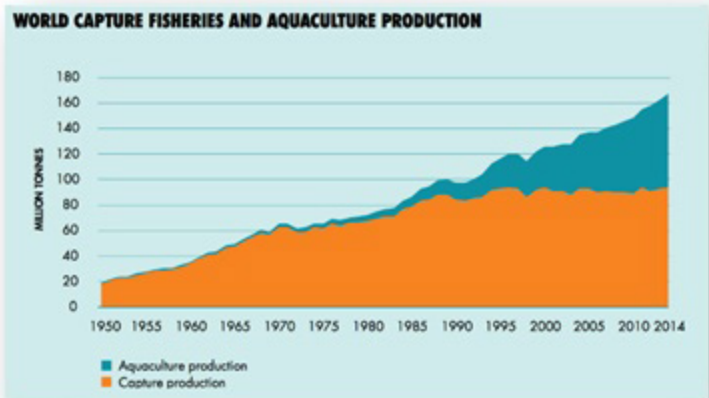


Figure 4. FAO: The State of World Fisheries and Aquaculture

Disease emergence in intensive and backyard livestock, poultry, and aquatic animal production can lead to the increased use of antimicrobials to treat disease. This can lead to increased antimicrobial resistance. Emphasis on judicious use of antimicrobials can help to reduce the emergence of antimicrobial resistance, however, this needs to occur on a global scale.

An important concern with the increasing emergence of diseases in food-producing animals is that some of the diseases are zoonotic. Some strains of avian influenza that have arisen primarily in Asia are a major concern. Most strains are not zoonotic, however there are strains that can transmit to people and have a high mortality rate. While this is currently a rare occurrence, there is grave concern that these zoonotic influenza strains could mutate to become increasingly transmissible from human to human. If this occurs and the same strains are infecting animals it will be essential to take aggressive steps to stop the spread by depopulating flocks that are, or may become, infected. This could result in severe consequences for nutrition and food security, especially for smallholder farmers.

An emerging disease that is currently causing food security concerns is African Swine Fever (ASF), which only infects pigs. It cannot infect people and is not a food safety concern. Asia and the European continent, except for the Mediterranean island of Sardinia, were free of ASF virus from the mid-1990s until 2007 when ASF was introduced to the Caucasus, a region bordering Europe and Asia. Since that time, ASF has spread into Eastern Europe, Asia, and is spreading into Western Europe as well.

In 2017 Vergne, T. et al. (Veterinary Record, 181:117) published a manuscript entitled, *Pig Empire under Infectious Threat: Risk of African Swine Fever Introduction into the People's Republic of China*. The abstract states:

“Pig production and pork consumption are very important to the People's Republic of China for both economic and cultural reasons. The incursion and spread of a disease such as African swine fever ... could have devastating socioeconomic consequences for both the Chinese and the global pig industry. The Chinese government consequently attributes a very high priority to ASF and is actively seeking to improve its preparedness.”

China currently produces approximately half of the pigs in the world. In addition, they import a considerable amount of pork from other countries. On August 3, 2018 an outbreak of ASF was discovered in China and has since spread widely throughout the country and into Vietnam and Cambodia. It is already negatively impacting pork production. Indications are that ASF will continue to spread in Southeast Asia where pork is a very important component of dietary protein. Many are concerned that ASF will continue to spread to more regions, including into the Western hemisphere. There is currently no vaccine for ASF and efforts to prevent the spread of this disease have had limited success.

There are also emerging diseases which threaten both food production and public health. These are important concerns for food security because they may result in the need to eliminate major populations of food animals to prevent infection of people. In 1998, a never-before-observed virus emerged in the Malaysian pig population, causing severe respiratory and neurologic signs. The virus spread to swine farmers and caretakers, resulting in more than 265 cases and over 105 human deaths in Malaysia and Singapore. There were also

reports of infections and illnesses in some other mammals in contact with pigs. A novel paramyxovirus, which was named Nipah virus, was isolated from a human patient. Both the U.S. Centers for Disease Control and Prevention and the Australian Animal Health Laboratory sent teams of veterinarians and other specialists to Malaysia within days of isolation of the virus. Working closely with the Malaysian government and scientists, these teams developed diagnostic tests and control strategies (including the culling of more than one million pigs) that resulted in eradication of the virus from the swine population. Scientists discovered that the virus is carried by healthy fruit bats and pig farming was banned in areas where the concentrations of bats are high. Between 2001 and 2018, there were no new cases of Nipah virus infection in Malaysia. However, the virus is still present in fruit bats in Southeast Asia, and in 2015 was detected on the Pacific island of New Caledonia. Human cases of Nipah virus encephalitis have been reported repeatedly since 2000 in Bangladesh, in some cases due to eating fruit or drinking unpasteurized fruit juices contaminated by fruit bat urine or saliva. Subsequent human-to-human transmission has also occurred.

Malaysia does not have a very big population of pigs because it is a predominantly Muslim country. However the fruit bats that carry the virus are also found in other countries in Southeast Asia that have very high pig populations including China, Vietnam, Thailand, and Cambodia. If Nipah virus were to emerge in pigs in those countries and spread like it did in Malaysia, it would likely be necessary to destroy a major portion of the pigs in those countries leading to a severe decrease in protein for human consumption.

If food animal production does not keep pace with the demands of a growing population, increased dependence on plant-based diets will be essential. This can be an option for relatively wealthy people who can afford a varied diet and access to nutritional supplements.



Figure 5

Poor populations have difficulty in meeting their nutritional needs, especially for growing children, with plant-based diets only. In 2017 the UN FAO estimated that there were approximately 820 million undernourished people in the world (approximately 10.9% of the population). In many countries more than 1/3 of household income is already spent on food. In the United States, an estimated 40 million people live in food insecure households. Increased costs for animal-based food could negatively impact nutrition for those people.

The increasing human and food animal populations make it inevitable that new and known human and animal diseases will emerge or re-emerge. These disease outbreaks will limit the ability to produce food animals at a time when more production is needed to provide sufficient high quality protein for the growing human population. Human dependence on livestock, poultry, and aquatic animals for food and livelihood limits the policy options for changing animal production practices. It is essential to protect animal health and food production into the future to be able to feed the ever-increasing human population. This will require increased emphasis on biosecurity, vaccine development and availability, access to veterinary care for backyard production, antimicrobial stewardship, and rapid response to disease incursions.

Jim Roth, DVM, PhD is a Distinguished Professor in the Department of Veterinary Microbiology and Preventive Medicine in the College of Veterinary Medicine at Iowa State University and a member of the National Academy of Medicine. He is the Director of the Center for Food Security and Public Health. Dr. Roth's primary area of research expertise is immunity to infectious diseases of food producing animals. He has testified before Congressional committees on biosecurity preparedness, on efforts to address bioterrorism and agroterrorism, and on the need for vaccines for foreign animal diseases. Dr. Roth served on the National Science Advisory Board for Biosecurity from 2005 to 2014.



Jane Galyon, MS, is the Program Coordinator for the Center for Food Security and Public Health in the College of Veterinary Medicine at Iowa State University. She is an Editor and contributing author for the Transboundary and Emerging Diseases of Animals textbook (also available in Spanish) which is provided to all veterinary students in the U.S.



Who Will Feed the World's Cities? The Rural-Urban Convergence

Professor Jessica Fanzo
Johns Hopkins University, United States

Rapid urbanization is seen as one of the most urgent priorities and the most defining development trends today, with more people living in cities than rural areas. There has always been an argued historic urban bias in international development, which has been blamed for slow and inequitable growth in low-income countries and in particular, rural areas (Lipton 1984). Perhaps it is time to think of urbanization and rural development as interconnected issues when it comes time to ensuring everyone achieves food security (Reardon and Timmer, 2014; IFPRI 2019).

The rural-urban convergence

By 2050, 70% of the world's population will be living in urban areas in search of employment and economic opportunities. Because of this surge in growth, one fundamental question is: *Who will feed these growing populations?* The answer remains uncertain, particularly because the average age of the world's farmer is sixty years old. De Fries (2014) argues that we are now transforming from farmer to urbanites and "our newest experiment-to feed massive numbers of people from the work of a few-is just beginning. The outcome is yet to be seen." While there are approximately 3.4 billion people currently living and working on about 500 million small-scale farms across the developing world, people are leaving rural places and many, whose parents and grandparents were farmers, want different careers and livelihoods (Fanzo 2017).

There are various push and pull factors that impact whether people leave or stay in rural places. Push or "distress" factors include inadequate farm output resulting either from temporary events (e.g., a drought) or longer-term issues (e.g., land constraints and tenure); a lack of insurance or credit for shortfalls in harvest yields; and an absence or failure of markets. There are also risks of declining capitals – natural, human, social and political. Pull factors include the uptake of strategic complementarities between activities, such as crop-livestock integration; specialization which brings comparative advantage particularly when paired with skills, technology and support; commercial or cash crop agriculture or proximity to an urban area that create opportunities for income diversification on and off-farm; and education, household wealth, and access to credit (Barrett et al 2001; Satterthwaithe et al 2010).

Overlaying these push-pull factors are global, regional and national issues of modern-day urban bias including decreased financial support from aid donors, and continued neglect of agriculture in international development, until very recently with renewed interest stemming from the Sustainable Development Goals and key country strategies like the United States Government's Feed the Future program as one example (Bezemer and Headey, 2008).

In many parts of the world, we are seeing encroachment of cities into peri-urban and rural communities as well as "ruralized" urban areas and "urbanized" rural landscapes. There is a loss of agricultural land due to urban expansion. Urban expansion will result in a 1.8–2.4% loss of global croplands by 2030, with substantial regional disparities. About 80% of global cropland loss from urban expansion will take place in Asia and Africa (d'Amour et al 2017).

It is not just the urban expansion that is changing rural lands, but the urban consumer demand for new diets. Rising incomes, urbanization and globalization, greater female participation in the workforce, and wider media penetration is driving demand for higher-value food products, as well as processed and packaged convenient foods (World Bank 2008). "These trends open new markets for a wide range of higher-value agricultural products and propel the evolution of the marketing system in many developing countries, with the entry and rapid growth of supermarket chains and the food processing and food service industries" (World Bank 2008). The perishability of most high-value agricultural products requires more sophisticated handling, transport, packing and storage, and rapid delivery to consumers to maintain quality and reduce physical and nutritional losses. While these trends could be seen as a boost to rural economies, in many developing countries and rural areas, lengthy, multi-actor supply chains, inadequate infrastructure (roads and electricity), and unstable markets add to the transaction costs, making it often, a losing game for rural food producers.

Why rural people and places still matter

When looking at human development statistics, rural people and places are being left behind despite the fact they still produce the majority of the food we consume around the world. Hunger and malnutrition dominate rural populations (although also high in many urban slums). Rural populations tend to have more stunting among children under the age of five as compared to urban centers (Paciorek et al 2013) and obesity and overweight is also rising in rural areas (See et al 2015). There is a need to invest in sound food security and nutrition strategies to tackle the malnutrition burden to ensure that farmer families are healthy.

At the root cause of hunger and malnutrition, extreme poverty is disproportionately

Rural people and places are being left behind despite the fact that they still produce the majority of the food we consume around the world.

concentrated in rural areas. The World Bank estimates that approximately 80 percent of the extreme poor are living in rural areas and around 60% work in agriculture (Olinto et al 2013). Approximately 800 million extremely poor people live in rural areas, and more than 600 million are engaged in agriculture (McArthur 2015). This pattern of rural deprivation is common across regions despite differences in overall poverty rates.

While urban agriculture holds some promise depending on the context, rural landscapes still produce the majority of food around the world and should continue to do so. Urban agriculture, the small areas within cities that are used for growing crops and raising small livestock for own-consumption or sale in neighborhood markets (Fanzo 2017), at this moment, is not sufficient to feed the world. Systematic estimates of the prevalence of urban agriculture are notably lacking, though a recent analysis of data from 15 developing or transition countries found country-level participation rates ranged from 11% to 69% (Zezza and Tasciotti, 2010). Constraints include insecure land tenure, polluted land and water, limited access to resources and support services, and lack of recognition by city authorities.

Eighty percent of the farmland in sub-Saharan Africa and Asia is managed by smallholders (working on up to 10 hectares) living in rural places. Smallholders provide up to 80% of the food supply in Asian and sub-Saharan Africa. In Australia, Latin America and North America, food coming from rural places are from medium to large holdings. Women comprise 45% of the agricultural labor force of developing countries up to almost 50% in Eastern and Southeastern Asia and sub-Saharan Africa (Samberg et al 2016). Smallholder farmers have more diversified landscapes and produce approximately more than 50% of the world's nutrients, making important contributions to the overall dietary diversity for the world's population (Herrero et al 2017). Developing-country mixed crop-livestock systems, most of them smallholders, make a contribution to the world's livestock products (Herrero et al. 2009).

Enhancing opportunities and reducing risks for rural people and places

There are many successful examples of how, through better linkages with urban centers, rural development can feed populated centers while jumpstarting entrepreneurship, empowering women, and sustaining rural livelihoods. Opportunities include organizing small and medium enterprise producers for marketing, providing

agricultural credit and micro-finance, and ensuring on-farm and off-farm opportunities for farmers. We need to creatively engage youth and women producers to diversify into higher value products by promoting activities that add value (processing, branding, and marketing). And last, investing in the underlying determinants of rural people by giving voice and harnessing social capital and cohesion within rural communities will provide resilience.

Rural women empowerment and self-agency are key. This means giving women the means of gaining information and access to new technologies, inputs and farming practices, increasing access to credit, and providing social networks to smooth consumption in times of hardship. There is also a need for sound investment in their human capital through access to education, health care and nutrition services to ensure they and their children are provided with the best opportunities possible (Fox et al 2018).

Summary

The world needs to remember that rural people and farmers are significant contributors to feeding the world, particularly growing cities. They also feed the world well in that they contribute a vast majority of the nutrient diversity in our global food basket. We cannot leave them behind. We must increase investment to revive and support rural places. This means investing in markets, roads, value chains, high value product development, and women, all which would have valuable multiplier effects for local rural economies. This also means that while they push on feeding the world, we too must ensure they are nourished and are food secure. There is nothing more important for human development and dignity.

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Food Security Challenges in Africa

Interview with Dr. Richard Munang
United Nations Environment, Kenya

In spite of Africa's large resources, it continues to be a net food importer. What are the reasons for this and what measures can be taken to reverse that trend?

Actually, Africa holds 65% of the world's arable land, and not less than 10% of the world's internal renewable water resources. Yet it spends up to \$35 billion to import food, which is not enough because up to 257 million people still go to bed hungry. Under status quo, the continent's import bill is projected to rise and hit \$110 billion by 2025, which is an over 200% increase in just 5 to 6 years. The urgency to arrest this scenario cannot be overstated.

Among leading causes driving imports is Africa does not have enough food because a lot of what is produced is lost. Africa's postharvest losses (PHLs) top \$48 billion each year; this exceeds what is imported by over \$10 billion. The implication therefore is that Africa must reverse its high PHLs as the first step to curb its escalating imports. Second, lack of competitive local enterprises that can produce food items that can compete on both quality and price metrics with imports means at times consumers prefer imports.

Addressing this calls for key interventions as follows:

a) Innovative clean energy solutions like solar driers, where Africa with the best solar resource in the entire planet is well placed, must be decentralized to high production areas to ensure value can be added at the point of production to enhance shelf life and quality of harvested produce. For example, right here in Kenya, over \$200 million worth of maize, a key staple is lost each year due to lack of adequate and effective drying solutions where unacceptable high retained moisture exposes it to pest infestation, molding and contamination rendering it inedible or unsellable.

But simply decentralizing solar driers to such farmers means recouping these monies and turning them to food secure homes and income opportunities for both farmers and solar drier entrepreneurs. This will go a long way to create much needed job opportunities in a country where 1 in 6 people are unemployed. In Nigeria, the second largest tomato producer, \$15 billion worth of tomatoes goes to waste for lack of value addition and preservation. Such solar driers decentralized to the farmers will mean they can dry surplus tomato, turn it into concentrate and sell to tomato paste processing factories in the country. Clean energy innovations are therefore critical to preserving quality and avoiding PHLs

that are driving food importation in the continent.

b) Markets are another intervention. Producers need to know that what they produce gets absorbed into markets. For this, nominal standards offered by standards regulators across Africa need to target ensuring their benchmarks can be implemented in such a way that they assist producers safeguard quality of their produce and tap niche markets among health, climate, environment and quality savvy consumers who are increasing. Millennials and the youth, who form the bulk of Africa's population at over 60% are a sophisticated consumer group that should be tapped, and Africa's produce grown using nature based approaches and processed using clean energy will can tap such niche markets.

c) Financing is also another area where cooperatives in the region can be guided to target financing clean energy systems that are critical to adding value and preventing PHLs as a way to expand their lending markets. And considering that such clean energy systems are capital assets, they can be used as security against such financing.

d) Facilitating the above solutions will call for an enabling suit of policies cutting across various ministries – agriculture, energy, trade, finance and cooperatives – to ensure coherent incentives are in place to unlock the above:

Meaning energy ministry fed-in tariff policies meant to enhance use of clean energy must be tailored to facilitate

increased investment in solar driers and similar clean energy systems relevant to powering agro-value addition.

That transport policies prioritize linking production areas to markets and collection points to minimize PHLs along the supply chain.

That trade policies prioritize unlocking niche markets that will absorb produce. That finance policies prioritize fiscal incentives for cooperatives – such as tax breaks – but geared towards financing specific clean energy acquisition like solar driers, fridges etc., for processing, preservation etc., by small-holder farmers to increase shelf life and eliminate spoilage.

It is such measures that will catalyze competitive local enterprises along the agro-value chain, and by this, eliminate PHLs and the allure of imported food items that at times are more competitive on both price and quality aspects.

What do you view as the impact of climate change on food security in Africa?

Climate change threatens to lower yields of leading staples by up to 40%, worsening an already dire food security scenario, with hundreds of millions going to bed hungry. This is at the production level, but doesn't end there. Under the changing climate, shifting climate patterns for instance means cereal crops which were traditionally harvested in the dry season and would therefore enable open sun-drying, are now harvested at peak rains. This is already

Africa must prioritize use of nature based EBA approaches known to increase yields by up to 128% under the changing climate.

happening in Rwanda, for instance. As a result, farmers without access to adequate drying facilities will not be able to dry their produce to acceptable moisture levels. High retained moisture exposes it to pest infestation, molding and contamination rendering it inedible or unsellable and this will perpetuate PHLs. However, simple solar driers, equipped with auxiliary bio-gas fired drying kilns that are already available in markets, can ensure such cereal crops are adequately dried even in seasons of high precipitation; and considering clean energy being used, do so without piling on the emissions that compound climate change.

So climate change is not only impacting productivity at the farm level, through say increased incidences of drought, but also impacting downstream value addition processes, all which call for innovative solutions that would turn such challenges into opportunities. The dual purpose biogas fired solar driers for instance are an example of a timely innovation to build resilience in downstream value chains. Use of nature based Ecosystems Based Adaptation Approaches (EBA) approaches at the farm level known to increase yields by up to 128% under the changing climate are another timely intervention at the upstream value chain.

How can food ecosystems be better managed in Africa?

Africa must prioritize use of nature based EBA approaches known to increase yields by up to 128% under the changing climate. EBA approaches like crop diversification, where in Zambia, farmers adopting improved sorghum varieties have increased their productivity two-fold from harvesting 1.5t/ha to 4.5t/ha. A similar technique in Malawi, where farmers are substituting maize for high value, climate resilient sesame has reduced food insecurity by an average of 1 month in the lean months and enhanced farmer incomes by 20%. Still in Malawi, nature-based actions of agro-forestry where 28,000 trees restored over 15ha of previously degraded lands along river banks have resulted in restored flow on a key river, to ensure a sustainable supply of irrigation and portable water. Indigenous soil and water conservation techniques like the Zai has rehabilitated up to 300,000 hectares of crusted and barren lands in Niger, restoring productivity. Right here in Kenya, using minimum tillage in Makueni County resulted in an over 300% increase in yields with additional benefits of improved soil fertility.

So scaling up and mainstreaming EBA approaches through integrating clean energy to ensure harvested crops are value added, and providing interventions in finance, markets and enabling policy as earlier expounded underpin the solutions to better agro-ecosystems in Africa.

What should be done to increase pertinent investment, foreign as well as domestic, to move Africa forward in addressing its food issues?

Increased reciprocity between policy and non-state actors who are consumers of policy is critical. The era where government formulates policy, implements, monitors implementation progress and reports back should be replaced by a new era of reciprocity where non-state actors who are consumers of policy leverage already existing policies to drive enterprise creation. It is then from such enterprise that will snowball into higher order investments. In Africa, the youth at 70% of the population, making them a 720 million strong constituency are the most significant non-state actors to be tapped into in driving existing policy provisions and demonstrating value, which will then attract more investors. Consider the PHLs where the continent is losing \$48 billion each year this is a fertile investment for actors across diverse sectors, from farming to logistics to clean energy to processing and finance, to tap. But unless these opportunities are proven viable, high-end investors will continue watching from a distance.

This is now where Africa's youth must come in to demonstrate viability. Leveraging on feed-in tariff policies that have made solar solutions affordable across the continent, and on digital financing solutions that continue to increase, and on available internet that is making a wealth of knowledge reachable through simple broadband internet, youth can come together, borrow small loans – some that are now being used for online betting – and

pool their resources to invest in acquiring solar driers that they can lease out to farmers to dry and preserve their produce. Such successful demonstrations at practical levels will not only engage such youth in gainful employment, but provide a feedback a mechanism for government to invest more in enabling policies and further draw high-end investors to tap remaining opportunities in areas of infrastructure, for instance, that the \$48 billion represents.

What impacts are food security issues having on poverty in Africa?

Agriculture is not only a source of food, but livelihoods for the majority – over 60% -on the continent. Right here in Kenya, agriculture is the mainstay of Kenya's economy, accounting for 65% of total exports, 75% of industrial raw materials, 60% of export earnings, providing income to over 80% of the population among key metrics. Maximizing productivity of this sector means creating income opportunities for the majority. The converse is also true. Productivity failures like what we see currently with \$48 billion being lost each year and \$35 billion expended in avoidable imports means \$83 billion worth of income, enterprise and macro-economic opportunities that would put poverty on the run are also lost.

So addressing inefficiencies along Africa's agro-value chains means unlocking a myriad of co-benefits for inclusive socioeconomic growth and combating poverty. This is where the continent should focus on.

Africa faces supply chain issues where

importing and exporting of food is concerned. What types of policies and development efforts can lead to an improvement of this issue?

Nigeria's tomato sub-sector provides a befitting analogy of these market dynamics. While the country is the second largest producer of tomatoes in Africa, it also stands out as the largest importer of tomato on the globe with over \$170 million or as high of \$360 million expended each year on importation. While these figures speak of a deficit, Nigeria loses over 50% of its tomato harvest, valued at up to \$15 billion. Among most significant policy steps put to address this scenario is the tomato production policy. This policy levies an import duty increase from 5% to 50% and an additional charge of \$1,500 per metric ton of imported tomato paste. The desired effect of this policy being to discourage importation of tomato and tomato concentrate.

But implementing this policy calls for enablers outside agriculture which I mentioned in my earlier response. Clean energy solutions like solar driers, solar cold storage, etc., will need to be decentralized to high tomato growing areas to ensure producers can guarantee quality output and compete in markets. Transport policies will need to prioritize linking production areas efficiently to markets to ensure transport costs do not render Nigeria's tomatoes unable to compete on price. Trade policies will need to ensure standards enforcement places Nigeria's produce on quality par to tap niche markets especially the health, environment and quality conscious consumers I earlier mentioned which should be a natural market considering most

producers use nature based, organic and non-chemicalized approaches that are a key decider among this niche market. Policies to ensure Nigeria's affordable financing will also need to be in place to enable local producers afford capital to enhance competitiveness and productivity of local production.

Driving the above paradigms calls for increased coherence in policy implementation across the various line ministries that intervene in the above areas. The structure of policy implementation across government needs to be revised to break ministerial and sectoral silos, and prioritize synergy in implementation to ensure different line ministries put in place coherent incentives that will address bottlenecks in above key areas concurrently. And by this, facilitate a coherent suite of incentives for non-state actors to engage and develop competitive local enterprises that will render imported tomatoes uncompetitive in the domestic market.

A similar approach of coherence in policy implementation across different line ministry policies to address bottlenecks with the aim for competitive local production needs to be applied in all other value chains in Africa. This will ensure Africa's over \$150 billion domestic food market is tied up to drive local enterprises.

Sub-Sahara Africa has encountered special food insecurity issues. What challenges are hindering efforts to solve them?

I think I have addressed this throughout my responses. To sum it all, Africa's food

insecurity issues cannot be looked at from the on-farm production level alone. Rather, must consider the entire value chain from production to value addition to linkages to markets. At the moment, more effort should be invested in addressing the postharvest losses where the continent is losing food worth \$48 billion each year and importing \$35 billion of what could be produced locally. Stopping this hemorrhage as discussed should be the primary priority in solving the continent's food insecurity challenges.

What are the main measures that can be implemented in order to successfully develop and implement food and agriculture innovation in Africa?

A skilled human capable of converting challenges into enterprise opportunities is the most sovereign capital and investment and is what Africa urgently needs to address. The value of human capital, the share of human capital in total wealth is 62%. That's four times the value of produced capital and 15 times the value of natural capital. Africa must get its human capital right as it is them who will drive urgently needed innovations to address productivity challenges faced in the continent.

For this, Africa's education must now move beyond being satisfied with theoretical proficiency, which is only the first step to tying this theory to developing practical solutions in areas focused on the continent's challenges and most strategic opportunities. Here, in addition to fostering enabling policy through refining and overhauling curricula as needed, hands-on mentorship where

graduates are taken through structured guidance to improve, refine, and align the skills they have from different disciplines, to tap opportunities in the strategic area of sustainably industrializing the continent's agro-value chains is critical action. Our work in the region is already providing this structural guidance to youth through what is called Innovative Volunteerism. Here, youth are guided to leverage the skills they have as a premium to forge partnerships with their contemporaries in other disciplines, and collectively complement their skills and be guided as a team to tap in closing inefficiencies along Africa's agro-value chains. In Kenya for instance, youth with skills in marketing, clean energy and ICT have been guided to complement their skills and come up with an application called EBAgroPamvoja that links agro-value chain actors to productivity solutions in organic inputs, clean energy to power processing & reverse PHLs, financing to recapitalize their enterprises, logistics to link effectively to markets, niche consumer markets among key intervening areas – all at the comfort of their smart phones and computers. Through EBAgroPamvoja, these youths are on track to convert Kenya's \$500 million worth annual agro-value chain inefficiency losses to food secure homes, enterprise opportunities for actors in different areas from agriculture to clean energy to logistics to finance etc., and at the same time earning their livelihoods through this connectivity solution.

So the suggestion is to focus on going beyond theoretical proficiency in all disciplines and proceed to tying theory to problem solving and opportunities tapping in strategic areas like industrializing

Africa's agro-value chains. This being achievable through policy actions in refining curriculum while benchmarking with best global standards and through investing in mentorship hubs as is happening with Innovative Volunteerism where those already out of the formal schooling can be guided to enhance their skills set and apply theoretical knowledge to solve challenges in strategic areas for the continent and countries.

So, Africa's education systems must be retailored as above as a foundational step of developing adequate human capital capable of coming up with competitive enterprises that drive solutions as discussed.



Dr. Richard Munang is the Africa Regional Climate Change Coordinator at the UN Environment. He is responsible for guiding the actualization of UN Environment's climate resilient development strategy for Africa in a manner that ensures human wellbeing. He is leading a continental wide strategic and innovative approach to Nationally Determined Contributions (NDCs) implementation ensuring climate aims of mitigation & adaptation are realized simultaneously with leading socioeconomic priorities of countries. By this, elevate climate action beyond a silo regulatory obligation as classically pitched to becoming an enabler of priority socioeconomic development. This approach is incentivizing demand driven, country-led shift to the low emissions development pathway across Africa. He has won many awards including but not limited to: the first person to win the prestigious African Environmental Hero Award 2016, he is the 2016 winner of UNEP's recognition highest award, the Baobab staff awards for Programme Innovation. He has been involved in enhancing human and institutional capacity building skills, as well as mentoring and empowering young professionals through the EBAFOSA country-driven model, allowing national stakeholders and institutions to lead in policy and ground actions, transferring continentally and globally sourced best practices to countries which in the processes have helped built both human and institutional capacities. Mentorship being a key pillar of any sustainable programming, he has mentored more than 5 million African youth to optimally apply the skills and knowledge acquired in class towards solving Africa's environmental and development challenges. He is the author of the book – *Making Africa work through the Power of Innovative Volunteerism*. This book outlines practical policies that countries in Africa should take to accelerate socio-economic transformation and achieve ideals of the sustainable development goals. He has participated in a wide variety of research projects and has published over 500 articles in both international peer reviewed journal and magazines. Dr. Munang holds a PhD in Environmental Change & Policy from the University of Nottingham and Executive Certificate in Climate Change and Energy Policy from Harvard University Kennedy School of Government.

Need for a Paradigm Shift in Efforts to Address Food Insecurity in Africa – Reduce Postharvest Food Losses

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Food insecurity remains a key challenge in Africa where approximately one in four people are undernourished. Over the years, most African governments have focused on increasing production to meet the food and nutrition needs of the ever-rising population, which is estimated to reach 2.5 billion by the year 2050. In this regard, strategies for food and nutrition security (FNS) have focused more on extensification (putting more land to production) and intensification (increased use of agro-inputs). However, these approaches to FNS are challenged by the limited and inelastic production resources (including land, water, energy, agro-inputs). Current food production systems are unsustainable and climate change poses additional challenge to sustainable agriculture in Africa. The emphasis on increased agricultural production without complementary interventions to ensure proper utilization of the food produced has contributed to the reported increase in postharvest food loss and waste over the years. According to FAO (2011), thirty percent (30%), or 1.3 billion metric tons (MT), of food produced for human consumption is lost or wasted in the food supply chain. In sub-Saharan Africa alone, the total quantitative food loss has been estimated to be over 100 million MT/year. For grains alone, the value of postharvest losses is equivalent to approximately USD 4 billion/year (at 2007 prices), which could meet the annual food requirements of about 48 million people. The value of food loss exceeds the annual value of grain imports into Africa. These losses exacerbate food insecurity and impact negatively on the environment as limited production resources (land, water, farm inputs and energy) are used to produce food that is not consumed.

This scenario calls for a paradigm shift from simply increasing food production through extensification and intensification strategies to more emphasis on better postharvest management and utilization of the food produced. The term “Postharvication” has recently been proposed and promoted as an integrated and comprehensive strategy to advocate for greater investments in education, research and application of innovative technologies and policies to improve the efficiency of food supply chains. This includes reducing losses and waste by developing diverse and value-added nutritious and safe food and other agro-based products, and facilitating trade and exchange through better quality control and assurance. Postharvication as a strategy for realizing the value of increased productivity argues that we must save the harvest and the investments already made in agricultural production. Postharvication must therefore be mainstreamed into the Agricultural

Postharvication as a strategy for realizing the value of increased productivity argues that we must save the harvest and the investments already made in agricultural production.

Transformation and Industrialization Agendas of Africa.

Postharvication will require focus and investment in five key areas (Figure 1): Markets, Infrastructure, Leadership and Knowledge, all built or anchored on strong and functioning local Institutions (I-MILK).

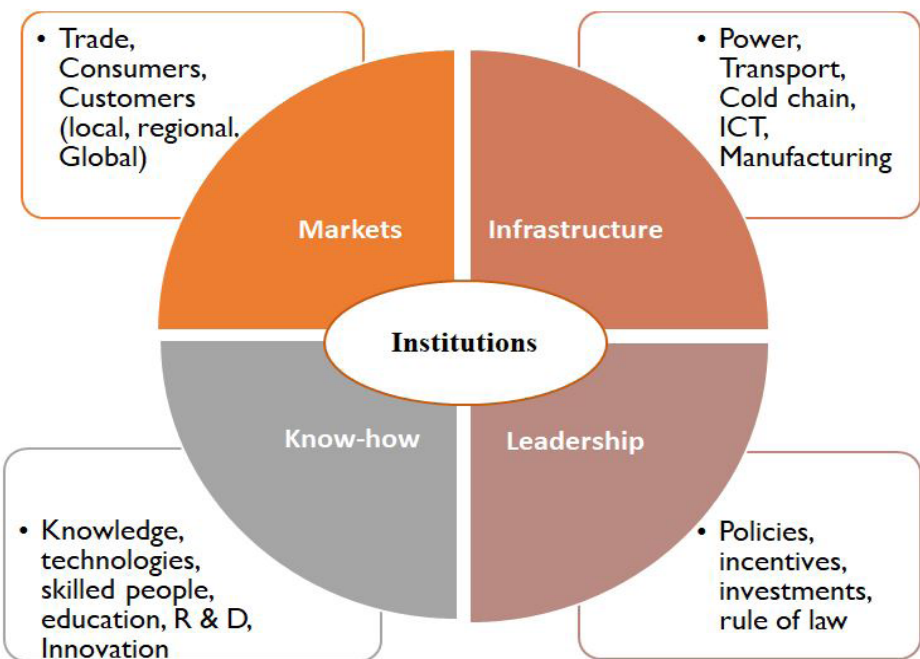


Figure 1. The I-MILK Strategy for Postharvication as a driver for agricultural transformation and industrialization in Africa (Prof. U L Opara, 2017)

Implementing the I-MILK strategy for Postharvication will require concerted effort from all stakeholders in the food supply chains to commit to the cause. In March 2017 the 1st All Africa Postharvest Congress and Exhibition convened diverse stakeholders in the food supply chain under the theme “Reducing Food Losses and Waste: Sustainable Solutions for Africa.” At the end of the congress, the stakeholders committed themselves to six actionable steps towards postharvest loss reduction as follows:

1. Commitment to reducing Post-harvest Losses anchored on 4Ps: Prioritization, Partnerships, Policy and Platforms aimed towards postharvest loss reduction.

2. Take Stock, Innovate and Scale up Appropriate Technologies to transform the African agricultural sector and all its sub sectors and address the huge postharvest losses. Indeed the requisite technologies for postharvest loss reduction but many remained underutilised due to various reasons including lack of awareness, unsuitability, cost, culture, and socio-economic limitations.
3. Value Chain and Product Diversification to support, empower and fulfil the requirements of large scale “anchor buyers” who should participate more in value chains for impact to be achieved.
4. Capacity Development at all levels of the value chain. This includes supply chain practitioners: farmers, traders, transporters, and everybody else involved in the supply chain. In addition, there is need to build capacity of education institutions to ensure adequate training on the subject in tertiary institutions. This will require training curricula development/review in addition to responsive and participatory research and outreach programs to address the knowledge and skills gaps in postharvest science and technology.
5. Measurements/Baseline Studies to establish the current status of food loss and capacity gaps of prioritized value chains against which success will be measured and underpin policy and practice to address the challenge with data gaps. This will redress the use and reuse of outdated estimates in shaping the data narrative in Africa. Through collaborative partnerships, academia and researchers must provide the data required to inform policy and practice.
6. Monitoring and Evaluation Framework to track progress made towards realization of the set goals and targets. The set targets include the Malabo Declaration (2014) whose target is to halve postharvest food losses by 2025. At the global level, United Nations SDG 12: Ensure sustainable consumption and production patterns has set a target to halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses by 2030.

The six actionable commitments present a multi-faceted approach that involves diverse stakeholders in the food supply chain. The diverse stakeholders must act in a complementary approach and build on each other’s strengths to ensure synergy rather than competition in the efforts to reduce postharvest losses.



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The Water-Food-Sustainability Nexus

Dr. Colin Chartres
CEO, The Crawford Fund, Australia

Increasing demands on the world's already scarce fresh water resources are fundamentally linked to agriculture and food. It has been argued strongly (EAT-Lancet Commission, 2019) that under a business as usual scenario, feeding the estimated approximately 10 billion global population in 2050 will be unsustainable in terms of available resources including water and nutrients, and will further damage already overstretched ecosystems and biodiversity. Complicating the picture are the growing impacts of climate change on agriculture and agriculture on climate change. The current impact of climate change on agriculture is highly variable but increasing variability of rainfall, resulting in more droughts and floods, and higher temperatures are some key factors that are already impacting production as evidenced by recent events in Australia. Furthermore, higher temperatures in the sub-tropics are considered to limit production of some key staples such as wheat. Additionally, higher temperatures will increase evaporation from water storages and reduce irrigation water availability. In 2014, the UN International Panel on Climate Change concluded that the agriculture, forestry and other land use sector are responsible for just under a quarter (~10 – 12 GtCO₂eq / yr) of anthropogenic GHG emissions, mainly from deforestation and from agricultural emissions from livestock, soil and nutrient management (IPCC, 2014). Whilst large agricultural producing countries including the USA, China, Brazil, Argentina, India and Pakistan are among the largest emitters, by 2030, growth in emissions will be greatest in Asia and sub-Saharan Africa due to increasing livestock and oilseed production.

In developing countries there are still over 800 million people suffering from malnutrition. This leads to childhood growth stunting and often a lifetime susceptibility to disease. In general, lack of access to food is not a problem of global food shortages, but results from inequality and poverty. Since the Green Revolution of the 1960s and 1970s, food production has kept pace with the growing global population. In fact, we currently grow enough to supply well over 2000 kcal per day to everybody. However, the world is facing a paradox of the simultaneous occurrence of malnourishment and over-nutrition. There are now globally 2 billion overweight and obese people in both developed and developing countries. Under- and over-nutrition both impose major threats to the individual, in terms of lifestyle diseases and in early mortality, and to health budgets of already impoverished countries. To some extent, obesity and overweight are consequences of availability of cheap and abundant calorie dense foods. This abundance of food also leads to significant waste of food that ends up in landfills. This puts further pressure on resources needed to

There are, however, a number of potential solutions that can be implemented to help us meet food production targets without further degrading our environment.

grow more food and further increases greenhouse gas emissions. In many countries, water is often the most stressed of these resources.

Whilst improvements in crop genetics due to plant breeding underpinned the Green Revolution, more widespread use of irrigation has been also critical to food production being increased. However, the world's fresh water resources are finite and limited to approximately 2500 cubic kilometres per annum. Agriculture already commandeers about 70% of this water. If we are to increase production by 60-70% to feed 9.7 billion people by 2050 as proposed by the FAO, agricultural water demand will inevitably increase. The magnitude of this increase is predominantly due to meet increasing demands for meat and dairy products which are highly water-intensive. However, by 2010 many major river basins including the Colorado (USA-Mexico), Murray (Australia) and Yellow (China) Rivers are in basins already deemed closed – that is, virtually all the water is used before it enters the ocean. Furthermore, major aquifers in many countries including Mexico, India and China are being pumped at rates far greater than their rates of natural recharge. Over the next 30 years we can expect other water uses to increasingly compete with agriculture for a greater share of fresh water further exacerbating scarcity. Domestic supply and industrial uses, including cooling water for thermal power plants and hydro-electricity generation, already figure significantly in this regard although some of these uses and irrigation are not mutually exclusive.

With respect to nutrients, there has been concern about supplies of phosphorus dwindling by mid-century, and whilst nitrogen can be synthesized from atmospheric sources, doing this industrially is energy intensive. Trace elements, vital to agriculture, are also becoming increasingly rare and costly.

Given the aforementioned factors, feeding a growing global population is not going to be without significant challenges. Currently, many of the externalities of agriculture that result in environmental degradation are not factored into the cost of food. These externalities include soil erosion losses, soil carbon reduction, sedimentation of water bodies, agrochemical pollution of surface and groundwater, and losses of biodiversity and ecosystem services such as pollination, natural water filtration and fishery habitats amongst others. However, there is little appetite politically to increase food prices anywhere to take externalities into account, and in poor countries, such an outcome would lead to more malnutrition and poverty. There are, however, a number of potential solutions that can be implemented to help us meet food production targets without further degrading

our environment. Given that agriculture, food, diets and resource over-use are inexorably linked, it is evident that the global food and planetary health challenges will only be met by addressing the entire food chain from farm to fork. Attention will need to be paid to efficiency of production systems, supply chain practices and human behavioral patterns relating to diet and waste.

Specific issues for attention include:

1. Sustainably intensify agricultural production

The key steps to sustainable intensification include closing yield gaps, raising water productivity, reusing waste water and nutrients, and compliance with a set of principles that afford environmental protection. Yield gaps are defined as the difference between biological potential (as set by sunlight, temperature and rainfall) and current actual yields.

Increases in crop yields come predominantly from combining genetic improvement with conservation agriculture based systems. The genetic improvements have come from both more intensive plant breeding and the application of biotechnology including the better understanding of genomics and the application of GM technologies. These developments have seen marked improvement in terms of disease and pest resistance, and in terms of adaptation to adverse environmental conditions including flooding (e.g., rice), salinity and acidity. There is a strong case to be made that there should be continued public sector investment in these programs to ensure innovations are made available as global public goods to assist farmers in developing countries capture benefits from these developments.

At the turn of the century, there was concern that crop productivity increases and the average annual rate in cereal yield growth had declined from 3.2 percent in 1960 to 1.5 percent in 2000. Fischer (pers. comm). However, in the following 15-year period, up to 2016, there has been a highly significant upturn in growth of world crop production (to around 2.3% p.a.). This is dominated, unlike in the previous 40 years or so, by a significant increase in crop area growth, but also accompanied by an upturn in yield growth in wheat and some key crops (e.g., pulses and rapeseed). Simply increasing the area of cultivated land continues to lead to adverse environmental consequences. Whilst continuing investment in crop breeding is going to be vital to further increase yields, there are significant yield gaps between potential biological yields and farm yields across much of Sub-Saharan Africa, West Asia, North Africa and parts of South Asia. Closing these gaps through improved varieties, irrigation technology and crop husbandry could have a big impact on the need for new land and on the environment (Byerlee et al., 2104),

Also vital will be techniques that reduce water transmission losses and evaporation in irrigation systems. These can be achieved by modernizing aging and leaking irrigation systems, moving from gravity fed irrigation to spray and drip systems, and measuring water productivity (crop per drop). However, there are trade-offs with increasing energy use that have to be taken into account in pressurized irrigation systems. The required infrastructure upgrades and productivity improvements are however, in most countries, beyond the financial and technical capacity of individual farmers, and as experienced in Australia have shown where there has been significant government involvement in promoting and incentivizing reform via policy, regulation and on-ground investment.

Finally, the key principles needed to protect the environment are well understood and include preventing off-site runoff of water and nutrients, maintaining soil carbon levels, eliminating forest clearing, and adherence to product certification schemes.

2. Reuse and recycling of water and nutrients

Reusing and recycling all sources of water and solid wastes, including treated effluent, can also make significant improvements in overall fresh water and fertilizer demand. This entire area offers great potential, but is not without risk. Previously, most societies did recycle these wastes, but the challenge now is to reengineer systems to utilize them efficiently in our urban environments and to enable nutrients to return to agriculture rather than being incinerated or buried at sea. Health risks can be safely managed as has been demonstrated with water processing and reuse, but there is still room for significant innovation and investment in developing recycling and reuse systems that are economically viable.

3. Reducing food waste on the farm, in supply chains and by the consumer

Essentially there are significant food losses due to poor harvesting and storage on farms, particularly in developing countries, and unnecessary losses due to perceived aesthetic requirements at the point of sale and with foods being thrown away at home. Estimates of food waste on a per person basis in developed countries are about 250 kg per annum. Globally this equates to the use, in production, of over 1.3 cubic kilometers of water. This is a little less than the amount of water required to increase irrigated production by 60-70 percent.

4. Improving diets

The Eat Lancet Commission argues that a large body of work has emerged on the environmental impacts of various diets, with most studies concluding that a

diet rich in plant-based foods and with fewer animal source foods confers both improved health and environmental benefits. This includes a more than doubling in the consumption of healthy foods such as fruits, vegetables, legumes and nuts, and a greater than 50% reduction in global consumption of less healthy foods such as added sugars and red meat (i.e., primarily by reducing excessive consumption in wealthier countries). They argue that if this diet is combined with halving food waste, closing productivity gaps and increasing the efficiency of resource use, we can feed almost 10 billion people within planetary boundary constraints. It is, however, important to stress that these recommendations should apply to the developed and emerging economies. In very poor countries access to meat and dairy products provide vital sources of protein, iron and other nutrients vital to the health of subsistence farmers and, in particular, women of child rearing age and their offspring.

5. Energy innovation on farms

I raise this issue because it has already been demonstrated that agriculture is a major and growing emitter of greenhouse gases and because there is considerable scope to reduce this. Solar water pumps are already available and effective, but I suspect there is considerable ground to be made with respect, inter alia, to capturing solar energy on farms and using it to power diverse machinery, converting waste into gas for cooking and other processes, increasing nitrogen use efficiency through the use of legumes and reducing animal methane emissions via rumen biochemistry modification.

Conclusions

The aim of this paper has been to demonstrate the nexus between agriculture, diet, resource use, and human and planetary health. The solutions are understood, but the understandable political drive for cheap food is leading to perverse environmental outcomes. Meeting the challenges that this leads to in Western countries is quite achievable with respect to the technological innovation required. In developed countries, governments can tailor policies to promote these goals. In developing countries coming off a low base, meeting the technological challenges will be more difficult because of lack of human and financial capital. In developing countries, foreign aid focused on developing sustainable intensification, improved water and waste management, and improved food supply chains is still needed. As has been pointed out by Bill Gates and the World Bank, helping develop agricultural systems is the best way to lift people out of poverty and to raise GDP. Universally, what is certain is that agriculture, and environmental and health scientists need to team up with behavioral scientists and the food industry to encourage healthy eating that will not only reduce disease risk, but also help the planet.

Acknowledgement

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Water Security and Business Strategy

Interview with Will Sarni Water Foundry, United States

What key factors need to be addressed to improve water sustainability?

Improved public policy and governance – a recognition that water is undervalued, overallocated and impacted by climate change. Essentially, the past is not a guide to the future with regards to water management to ensure economic development, business growth, ecosystem health and social well-being.

How should the private sector adapt water security and similar eco issues into strategic plans? What are the keys to implementing such strategies effectively?

A corporate water strategy needs to align and support a business strategy. This is more inclusive than a water stewardship strategy which is typically focused on conservation. A corporate water strategy should consider elements of innovation and creating business value (e.g., brand equity).

Would you share any success stories you've encountered concerning increasing water efficiencies?

I would view this as which companies are engaged in a forward looking and

comprehensive water strategy. Companies include; ABInBev, Nestle, Microsoft and Intel.

ABInBev – actively engaged in supporting their supply chain partners in sustainable agriculture and investing in innovative start-ups focused on sustainability through their venture investment fund – ZX Ventures.

Nestle – actively engaged with agricultural supply chain (Creating Shared Value strategy) and commitment to Alliance for Water Stewardship certification.

Microsoft – commitment to reducing water use at data centers and supporting innovative initiatives in leveraging digital technologies through their AI for Earth program.

Intel – Collective action and Replenish Strategy. Very engaged with stakeholders in addressing water security and sustainability.

Have enough efforts been made to educate the public and private sectors about water issues and risks?

A corporate water strategy needs to align and support a business strategy.

No. We need to vastly improve dialog and engagement with civil society and the public sector on the reality of water – it is overallocated, underfunded, poorly valued and this is not a “drought.”

What emerging water related technologies and processes do you find particularly exciting at the moment?

Digital applications in data acquisition and analytics in the agriculture, industrial, utility and home sectors. Essentially, smart; agriculture, homes, industries and utilities. Refer to the following articles on my point of view and focus.

[*From Dirt to Data: The Second Green Revolution and the Internet of Things*](#)

[*Harnessing the Fourth Industrial Revolution for Water*](#)

[*What is a Water Utility in a Digital World?*](#)

Water innovation is an area for considerable business development. Is the private sector taking advantage of this opportunity? Not only to turn a profit but to provide products and services that serve related social and eco issues?

Yes, to some degree. Again, in my view some of the best examples are Microsoft (AI for Earth program), Intel (smart agriculture), ABInBev (with ZX Ventures), Google (Google Earth applications) and Amazon (partnership with techstars – smart home focus).

Will Sarni is an internationally recognized thought leader on water strategy and innovation. He has been a sustainability and water strategy advisor to multinationals, water technology companies and NGOs for his entire career. Will works with multinationals on corporate water strategies, water technology innovation and water market entry strategies. His work with water technology companies is as a strategy advisor and investor.



Prior to Water Foundry Will was a Managing Director at Deloitte Consulting and led the company's water strategy practice. He was the founder and CEO of DOMANI, a sustainability strategy firm, prior to Deloitte.

As a seasoned author Will has written numerous books and articles and continues to present on subjects such as the value of water, innovations in digital water technology, the circular economy, and the energy-water-food nexus. He is the author of: *"Corporate Water Strategies"* (Earthscan 2011, and in Chinese by Shanghai Jiao Tong University Press 2013); *"Water Tech – A Guide to Investment, Innovation and Business Opportunities in the Water Sector"* (Sarni, W. and Pechet, T., Routledge 2013); *"Beyond the Energy – Water – Food Nexus: New Strategies for 21st Century Growth"* (Do Sustainability 2015), and his latest books *"Water Stewardship and Business Value: Creating Abundance from Scarcity"* (Sarni, W., and Grant, D., Routledge 2018) and *"Creating 21st Century Abundance through Public Policy Innovation: Moving Beyond Business as Usual"* (Sarni, W. and Koch, G., Greenleaf Publishing 2018). He is currently working on *"Digital Water: New Technologies for a More Resilient, Secure and Equitable Water Future"*.

Will is a Board Member of FloWater, Project WET, as well as a Project Board Member of 10.10.10, and Founder and Chairman of WetDATA.org. He was a 2016 XPRIZE Bold Visioneer for the Safe Drinking Water Team and is on the Scientific Program Committee for Stockholm World Water Week; the Executive Council of NOAA's National Integrated Drought Information System (NIDIS); the Editorial Board of the Journal of Water Security and a Technical Advisor for the Climate Bonds Initiative: Nature-Based Solutions for Climate and Water Resilience.

Please Make Avocados Sustainable Again!

Christian Häberli
World Trade Institute, Switzerland

Where is the Problem?

The production of three avocados (1kg) requires one thousand liters of water. No problem if and where rains are abundant – but exports frequently originate in arid areas. It is called “virtual water” when we eat the fruit. But it is real fresh water for which many users are competing, for instance in Apútzio de Juárez (Michoacán, in Mexico, the world’s largest avocado producer by far). Some plantations are causing deforestation, said to imperil one of the most beautiful American butterflies, the monarch, who fly thousands of miles to their winter home in the nearby Monarch Butterfly Biosphere Reserve. Near Cape Town (South Africa), in 2018, avocado trees were irrigated, even as the mayor of the city counted the days until the whole area would be running out of water. And, while cash crop producers in Ica (Southern Peru) are among the most efficient water users in the world, their hi-tech irrigation is tapped from slowly disappearing ground water. Moreover, their plantation workers live in nearby villages with hardly ever a drop of rain, with poor soil management, and without fresh water irrigation for their food crops. Drinking water is brought by a truck, and it costs four times the price of tap water in Lima. Remuneration is above minimum wages but there are few if any jobs elsewhere.

All this seems to point to a simple conclusion: one of our favorite luxuries is neither ecologically nor socially sustainable – and it is drying up. Where water allocation is biased in favor of export crops (and minerals), avocados are unsustainable from an economic point of view as well.

Should we then stop eating unsustainable avocados? Or should we demand a credible label and pay twice the price for (short-term) sustainability? Assuming this works, would such a rich consumer-driven initiative make all avocados sustainable, or just give us a good consciousness?

... one of our favorite luxuries [avocados] is neither ecologically nor socially sustainable – and it is drying up.

The Race to the Bottom

Commercial importers in Northern America and Europe try to satisfy retailer and consumer demand in terms of price and quality, with only sparse information on origin and mode of transportation, let alone environmental or social production standards. Commercial producers are competing with little regard to environmental or social considerations. Regulators are finding water allocation to be one of the most pressing problems, not to mention climate change and salinization. Water demand by urban and industrial consumers, miners, and cash croppers is growing rapidly. In many countries local food production is less water efficient, and/or not a political priority. Instead of more sustainable policies, governments prefer short-term gains by trade and investment support for a precious cash crop. Hence, they increasingly engage in litigation over different phytosanitary standards, packaging and labelling requirements, or production subsidies. The implicit export bias in international trade and investment rules offers few, if any, incentives for sustainable policies.

Nobody seems to take the longer view, where water is likely to become the most contentious factor in a food value chain marked by global warming. Are our avocados a short-term delight? More importantly, can producers defy the laws of competition and become sustainable? And, if we do not care about the environment, or poor peasants on the other side of the world, will our children have to find this lovely fruit on a Planet B?

Any Solutions?

As an agricultural trade lawyer, I always look at the tools, rather than at the objectives of a policy. Sustainability in this sense is a matter of priorities between different policies. Given the conflicting interests between producers, exporters and retailer/consumers, both in different countries and over time, feasibility often boils down to what is “best available”. Starting with labelling i.e. at the end-of-line, some (not all) consumers may well be interested in more information on how their avocados were produced – like, say, growth hormones in beef, shrimps prepared by child labor, or Nutella from palm oil in burning rainforests. A good label might help assuage rich consumers’ concerns. But this would require a truly sustainable production practice and monitoring from farm to fork. Indeed, consumer prices would increase, even though benefits would not necessarily accrue to farm laborers or bring more drinking water for rural populations and irrigation for small croppers. Examples like labels for organic food or fair trade show a good, but extremely limited, potential. My wild guess would place labelled avocado sales at much less than 10% of total consumption in rich countries.

The key challenge is to stop this race to the bottom. In my opinion, avocado sustainability can only be ensured by a worldwide production standard. In the absence of a binding commodity agreement, some private initiatives for fruits and vegetables organizations could

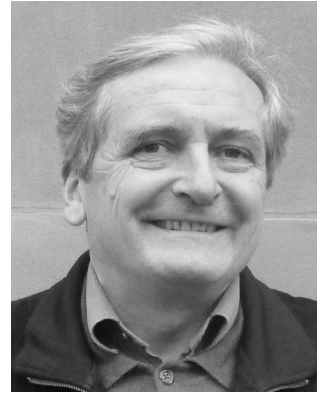
play a useful role. Global G.A.P., for instance, is a global organization promoting safe and sustainable agriculture around the world. It sets voluntary standards for the certification of agricultural products, based on good agricultural practices for, say, pesticides, or packaging. The standards are defined by food industries and retailers, increasingly in consultation with large producers even in developing countries. More recent initiatives, for commodities like cotton, soybeans and palm oil, have a poorer credibility record. However, because of the underlying policy challenges for avocados, I consider that consumer driven initiatives are unlikely to succeed, without binding minimum production standards, agreed by regulators in the main producer areas. In order to avoid too many free-riders, adherence of a critical number of producers is required.

“Sustainability” for avocados would thus need to be initially defined by the main producer countries. Criteria would need to address all three facets: (i) *social sustainability* could be very simply expressed in terms of farmer revenues, at least in line with local wages for comparable work, and sufficient to sustain the most basic family needs; (ii) *environmental sustainability* would mainly address water allocation for all poor users in the production area; and (iii) *economic sustainability* would ensure that production is and remains competitive without subsidies, and without what is called “eco-dumping” and “socio-dumping”. Such standards would need to be phased-in over a certain period of time; locally adjustable on an equivalence basis; independently monitored; and enforceable, if need be, by domestic fines, trader boycotts, or trade sanctions. Difficult enough, right? So please don’t add rich consumer fancies adding organic and fair-trade conditions to such a difficult project...

Granted, an intergovernmental sustainable avocado production standard looks like mission impossible, especially when we look at all the challenges faced by poor countries. Retailer and NGO pressures may help – or prevent – a more comprehensive initiative by competing producers. And just as for other initiatives, intergovernmental organizations such as FAO, UNCTAD, UN Economic Commissions, IPPC, WTO, ITC, OECD, and Regional Trade and Investment agreements are yet to play a more proactive and pro-development role. Failing that, the race to the bottom might continue right to the last non-sustainable fruit.

Do you want to join an Avocado Round Table? If you are a stakeholder, you are welcome – and please say not what should be done by others, but what you will do to ensure a sustainable future for avocados!

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Conflict and Cooperation over Internationally Shared Water Resources: Context, Indicators, and the Role of Universities

Professor Aaron T. Wolf
Oregon State University, United States

Setting and Context

Water management is conflict management. Water, unlike other scarce, consumable resources, is used to fuel all facets of society, from biologies to economies to aesthetics and spiritual practices. Moreover, it fluctuates wildly in space and time, its management is usually fragmented, and it is often subject to vague, arcane, and/or contradictory legal principles. There is no such thing as managing water for a single purpose—all water management is multi-objective and based on navigating competing interests and values. Within a nation these interests include domestic users, agriculturalists, hydropower generators, recreationists, tribal and indigenous communities, and environmentalists—any two of whom are regularly at odds—and the complexities in finding mutually acceptable solutions grow exponentially as more stakeholders are involved. Add international boundaries, and, without careful re-crafting of the issues involved, the complexities increase exponentially yet again.

There are 310 watersheds around the world that cross the boundaries of two or more nations covering 45.3% of the land surface of the earth, including about 40% of the world's population, and accounting for approximately 80% of global river flow. In addition, there are more than 600 transboundary aquifers, complicating cross-border water management even further.

Surface and groundwater that cross international boundaries present increased challenges to regional stability because hydrologic needs can often be overwhelmed by political considerations. Water is shared across the borders of Israelis and Arabs, India and Pakistan, Azerbaijan and Armenia, and all 11 countries of the Nile basin. While the potential for paralyzing disputes is especially high, history shows that water can also catalyze dialogue and cooperation, even between especially contentious riparians, those who live along a river, or those who share an aquifer. (Interestingly, “riparian” has the same root as “rival” signifying that those who share access to a river by nature can have competing interests.) In 2018, and for the fourth year in a row, the *Global Risks Report* of the World Economic Forum placed “water crises” among the top five global risks in terms of impact.

There is some room for optimism, though, notably in the global community's record of

...rural people and places are being left behind despite the fact that they still produce the majority of the food we consume around the world.

resolving water-related disputes along international waterways. Oregon State University's Transboundary Freshwater Dispute Database documents more than 600 treaties related to shared waters as well as more than 1800 events of water-related cooperation over a 60-year period, vastly overwhelming the conflictive events by two to one. Notably, historically, there has only been one actual war fought specifically about water resources, and that was 4500 years ago.

Many of the most vehement enemies around the world either have negotiated water sharing agreements, or are in the process of doing so, and once cooperative water regimes are established through treaty, they turn out to be impressively resilient over time, even between otherwise hostile riparians, and even as conflict is waged over other issues. The precedent set by the positive record of cooperation on international rivers highlights the need for similar cooperative water sharing agreements on other transboundary basins and aquifers, and it provides support for cooperation through hydrodiplomacy within these basins. Violence over water across a border seems neither strategically rational, hydrographically effective, nor economically viable. Shared interests along a waterway or an aquifer seem to consistently outweigh water's conflict-inducing characteristics and also the impacts of climate change.

Nonetheless, shared waters clearly induce tension between countries, often exacerbating already tenuous relations and precluding efficient water management. In fact, a general pattern of unilateral development and transformation has emerged over time, known as the "crisis curve". Riparians implement water development projects unilaterally first on water within their territory, often without consultation with their neighbors, in attempt to avoid the political intricacies of the shared resource. At some point, one of the riparians, generally the regional power, will implement a project that impacts at least one of its neighbors. This might be to continue to meet existing uses in the face of decreasing relative water availability. This project, which impacts one's neighbors, can, in the absence of relations or institutions conducive to conflict management, become a flashpoint, heightening tensions and regional instability, and requiring years or, more commonly, decades, to resolve. Currently, for example, Lao dams are creating concern on the Mekong, as is Ethiopian development on the Nile, and Tajik infrastructure on the Amu Darya in Central Asia.

In the meantime, water quality and quantity degrade, negatively impacting upon the health of dependent populations, and ecosystems. This problem only worsens as the dispute intensifies. Disparities (economic development, infrastructural capacity, political orientation)

between nations further complicate international water resources management. In the case of groundwater, very few agreements or institutions actually exist between countries over the shared use of groundwater, therefore limiting capacity for preventing the intensification of a dispute over groundwater.

Indicators and Early Warning

To help get ahead of the crisis curve, a number of entities, including the governments of the Netherlands, Switzerland, and the United States, as well as their non-governmental partners, have proposed early warning or “hot spot” maps to help identify “basins at risk” of conflict. In response to this challenge, one focus is on international basins, and on a spectrum of possible hydropolitical interactions, from intensely then mildly cooperative through disputes, conflict, and finally violent conflict.

Prevailing wisdom assumes that indicators of transborder water disputes include scarcity, degradation, and/or climate change yet, in general, most parameters commonly identified as indicators of water conflict are only weakly linked to dispute in empirical studies. The world is rife with settings where water quantity and quality are being degraded to where shortages of clean freshwater threaten lives and human and ecosystem health. Yet these are not necessarily where geopolitical tensions and violence will result. Rather, there is a key relationship, derived empirically, underlying hotspot identification:

The likelihood and intensity of tensions related to water resources rises as the rate of change within a basin exceeds the institutional capacity to absorb that change.

This suggests that sudden changes, either on the physical side (primarily upstream dams or large-scale irrigation plans) or the institutional side (e.g., new political boundaries, new governments) are more hazardous than “creeping changes” (e.g., decreasing quantity or quality, including due to a changing climate). Regions with the greatest potential for political tensions, then, are those with *both* rapid physical change *and* the absence (or the deterioration) of cooperative institutions, such as treaties, river basin organizations (RBOs), or technical working groups, or when relations between states are especially tenuous over other issues.

The relationship between change and institutions as described above is a critical one to understand. In most of the developed world, both institutions and technologic options are strong, as are alternatives such as food imports and desalination, such that cross-border violence is unlikely. In much of the developing world, while strategies for adapting to hydrologic changes are fewer, so is the capacity to mobilize cross-border violence, especially if their neighbor is more powerful. These settings too are not necessarily places where conflict would result, except for small-scale tribal or ethnic violence.

The hotspots that have been identified in past empirical work, then, are those in between these two extremes – areas where countries have the capacity to develop their water resources, driven by population and economic growth, but where institutional capacity may not be able to adapt to these new changes, and where greater variability brought on by climate change may well threaten existing agreements. When assessed in combination, it becomes clear that major water projects such as dams, diversions, or development schemes *in the absence* of legal agreements, collaborative organizations, or overall positive relations that can mitigate for the transboundary impacts of these projects, are the most likely settings for tensions.

Universities as Facilitators

The global university community, with its inherent mission of teaching, research, and service, has much to offer in addressing the challenges of preventing and resolving transboundary water disputes. Networks of various formalities of universities with expertise in water cooperation and diplomacy have existed since 2002, including through the UNESCO PCCP (from Potential Cooperation to Cooperation Potential) program.

In these last 17 years, the world of water diplomacy has changed. Water crisis, conflict and cooperation, are now high on the agenda of governments. A growing number of institutions have included water cooperation, diplomacy or related themes permanently in their work portfolio, and more funding has become available to facilitate meetings between academics, practitioners and students working on water cooperation and diplomacy. Reviving the community, strengthening it, and including new partners is now more relevant than it ever was, and the idea to create a renewed network, the Universities Partnership for Water Cooperation and Diplomacy was announced at the 2018 World Economic Forum in Davos, Switzerland in February 2018.

With a global hub at the University of Geneva, Switzerland, coordinating universities include the German-Kazakh University in Kazakhstan, IHE Delft Institute for Water Education in the Netherlands, Indian Institute of Technology Guwahati, the International Water Management Institute, Oregon State University in the USA, the University for Peace in Costa Rica, and the University of Zimbabwe. Twenty universities on five continents have expressed interest in participating and scoping meetings were held in Delft, the Netherlands in 2018 and 2019 to develop a workplan.

The institutions involved in the Partnership comprise both policy and technical expertise within and beyond their respective regions and across academic disciplines. The local networks of each partner institution extend the reach of the consortium to include policy makers and practitioners and thus will encourage dialog and capacity-building between North and South, East and West, and among different professional sectors.

The activities of the Partnership focus on key socioeconomic and geopolitical issues in shared water management at local, regional, national, and international levels. All activities are to be explicitly linked and integrated within three coordinated focus areas:

- 1) Coordinated applied research;
- 2) Shared and unified data accumulation, analysis, and distribution;
- 3) Capacity-building training for local, regional, and international basin stakeholders, as well as for graduate students in water-related fields.

Universities offer tremendous resources in helping to build capacity for effectively and peacefully managing shared waters. By coordinating and focusing our energy and expertise, the Universities Partnership can provide a valuable resource for research, teaching, and global service in shared water dispute prevention and resolution.

Closing and Caveats

One caveat on these discussions: the trends and indicators identified here relate specifically to cross-border tensions. In other work, we and others have documented a prevalence of tension and violence around water *within* countries, whether between states, tribes, or users. Efforts are ongoing to identify internal indicators as well, and we believe that the overall relationship between change and institutions holds, just that the type of institutional capacity changes dramatically within a country from capacity internationally.

Finally, though, the greatest threat of the global water crisis to human security comes not from the challenges of cross-border violence, but “simply” from the fact that millions of people still lack access to sufficient quantities of water at sufficient quality for their well being, and projected population growth and a changing climate will only make this problem more acute. In this context, poverty alleviation becomes a critical tool not only in saving lives, livelihoods, and ecosystems, but in bolstering individual, regional, and global security as well.



Aaron T. Wolf is a professor of geography in the College of Earth, Ocean, and Atmospheric Sciences at Oregon State University. A trained mediator/facilitator, he directs the Program in Water Conflict Management and Transformation, through which he has offered workshops, facilitations, and mediation in basins throughout the world, and has acted as consultant to US Government agencies, the World Bank, and several international governments and organizations on various aspects of transboundary water resources and dispute resolution. He is author, most recently, of *The Spirit of Dialogue: Lessons from Faith Traditions in Transforming Conflict* (Island Press, 2017).

A Holistic Approach to Effective Sustainability

Interview with Professor Elisabeth Bürgi Bonanomi
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In recent works, you discuss the history, conceptualization and institutionalization of sustainable development as a concept. How do you define “sustainable development”? And how does this relate to other sustainable environmental issues like food security?

In my book [Sustainable Development in International Law Making and Trade](#), I look at how sustainable development could be viewed from a legal perspective - how the law would have to deal with sustainable development. It's more than a concept, and it's overarching. It can be regarded as a legal principle. What it's doing is to align policies and place focus on the trade-offs and in-between areas of policy. There are economic and social policies surrounding sustainability, but there will always be trade-offs between them. Economic policies steer in one direction, social policies in another, and environmental policies again in another direction. Sustainable development governance should focus on resolving conflicts of interest between these different regimes.

In the book, I illustrate how sustainable development – if conceptualized as a legal principle – could help resolve such multidimensional conflicts of interest. I build upon the approach developed by Katja Gehne. The legal principle of sustainable development is a multidimensional, methodological norm - and by that, I mean

a procedural norm. If applied, it ensures decision-making and responsible law-making procedures that are shaped in a way to make sure that trade-offs become visible and get worked on. Usually, if you look at public administrations, the economic department is working on one side of an issue and the environmental department is working on another side. There aren't truly integrated procedures between them. So, if you establish sustainability-oriented policies, you would consistently ask how a draft policy may impact the social, the environmental and the economic dimensions, and how the policy could be shaped in order to ensure synergies and mitigate conflicts. In a sustainable development context, this would have to be the norm. To apply the principle of sustainable development consistently to governance processes, it's a call to have holistic procedures instead of having sector-specific perspectives.

An example of this is Macron's climate policy in France. By increasing prices of gasoline, the policy targets the environmental side of the problem, but it does not do so in a socially embedded way. With trade policies, it's the same thing. If, for example, Switzerland negotiates trade agreements, it would not consider the perspective of all concerned stakeholders beforehand. So, if they negotiate strict intellectual property divisions, they will not ask who would be the losers and the

winners of this regime. They would rather place the interest of its private enterprises at the forefront. Most countries still follow such a mercantilist approach instead of a cooperative approach.

But if you applied the sustainable development principle correctly, you would have procedures to make sure that all concerned perspectives are put on the table. You would ask how a stricter intellectual property regime would influence smallholder activities in seed production; the impact on prices of the most needed medicines; the extent of promoting sustainability-oriented innovations, etc. The task would then be to look for the optimal solution that accommodates different interests, including the interests of those most vulnerable.

How much impact do you feel the economic and trade systems that have been created have on sustainable development values/norms? Are there differences in how these systems of governance are perceived between the Global North and Global South?

Yes, there are. As a sustainability researcher, I would say that you can't answer the diverse questions as yes or no. You have to look at the context. There's always a claim for having a nuanced perspective on something. If you open up trade, it can be very beneficial to many

actors, but it can also be detrimental. It depends on the context and the actors you're looking at. In agriculture, in countries of the Global North such as Switzerland, and also the United States to a certain extent, a protectionist outlook on trade policy is preferred. In the Global South, people tend to promote an open trade policy with Global Northern countries. They would argue against Northern countries closing down borders to prevent or curtail trade of their agriculture products. From a sustainability perspective - including a perspective on human rights - trade rules should be developed that are context sensitive. For example, in Switzerland, there has been discussion to open up borders specifically for processed, sustainably-produced agricultural products that are very relevant for sound rural development in developing countries while still protecting sensitive sectors. For a long time, this kind of nuance was not possible, a policy underlined by sustainability incentives, with opening up trade on one side and protectionism on the other. So it is important to open up our minds and push the discussions in this direction.

You have in recent works discussed food sustainability through sustainable trade relations. I wondered if you could discuss with us a bit more about what you mean by "food sustainability" and for whom? And about development of trade relations as it relates to food

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sustainability – are there true “winners” versus “losers” in this interdependence?

Food sustainability is a new concept that tries to integrate social, economic and environmental concerns relative to food security. Enough food must be produced, but in a way that is not detrimental to biodiversity, etc, and also ensures that benefits of food production are equitably shared along the value chain. How then can you shape policies to promote an “enabling environment” for food sustainability? We usually take a food system approach towards food sustainability. You have to look at all associated policies that define the way food is produced, how food is processed, where the inputs originate, who produces seeds, the availability and quality of trade markets, and whether or not certification is implied. Altogether, this establishes the food system. In order to transform existing food systems into a more sustainable system, you should consider adaptation of policies at all levels of governance, including the local, national and international level.

What happens in the North, and how agricultural policies are shaped there, impacts what happens in the South. It's very interlinked. If there wasn't intense meat production in the North, soy production in the South would look differently, or they would produce other products with more added value. All the drivers are entangled, with pull and push factors.

In Switzerland, there have been trade referendums taking place. The Green Party wanted to introduce sustainability criteria in trade policy to distinguish at the border between sustainably-produced and

unsustainably-produced products. With this, sustainably-produced products would have had a lower tariff than those that are not sustainably-produced. This initiated quite a debate, raising some interesting questions: Is it possible to have this distinction? Is it not paternalistic? The referendum was rejected but the idea is gaining momentum. For instance, it has materialized in the new trade agreement between the EFTA countries (Switzerland, Norway, Iceland and Liechtenstein) and Indonesia.

The idea is one of improving the market environment for those products that are of high sustainability value. For example, in Bolivia, there is a strong cluster of soy producers and small farmers who are producing soy to export - this is their cash product. At the same time, there are farmers who try to produce in “diversified farming systems” but they don't have good markets available. They end up starting a business, but they often give up.

So the goal would be to build trade systems and trade relations that would strengthen weaker and marginalized producers in order to maintain or improve biodiversity. The agro-industrial system is “uniformity-driven.” Then you have diversity-based food systems on the weaker side of the whole picture. How can you strengthen these diversity-based systems, which are very important from a sustainability perspective? Former UN Special Rapporteur on the right to food, Olivier de Schutter, put it very nicely, “Uniformity is the paradigm of the 20th century, and diversity is the paradigm of the 21st century.” We need to explore how to strengthen diversity-based systems by creating more nuanced policies, including

trade policies.

Here in Switzerland, we have very intense agricultural production that causes lots of environmental problems. People want to protect their farming system but also seek to make it more environmentally friendly. “More environmentally friendly” would mean to produce in a more extensive way, hence a bit less, and open up the borders to some extent. Requiring that imported food has been produced in a sustainable way could benefit producers in the export countries and also contribute to a shift towards a more sustainable way of production. Hence, reform in Switzerland and elsewhere would go hand in hand.

In one of your recent papers on sustainable investment in land in the Global South, you mention the need for considering multiple issues if policy coherence on sustainable development is to develop. Of the issues you mentioned sovereignty over natural resources, peoples’ right to self-determination, responsibilities of states (home/host to investors), and international institutions – which of these issues do you see as having had the most influence to date on policy-making? And how have these particular actors impacted policies?

What we have been observing in many countries is bottom-up processes to influence change in sustainable development. You always need bottom-up processes to be successful. You cannot start from scratch and commit a top-down approach to initiate process towards sustainability. But the law can provide an

enabling environment for such processes to thrive. At the same time, bottom-up processes can be strengthened by international governance. An example can currently be found in Argentina where there is fighting for natural resource protection. If they can link their arguments to what is discussed at the international governance level, it will be easier for them to obtain resources and leverage. It’s an interactive process. You always need top-down and bottom-up approaches working together; a framework being provided from above, but at the same time, bottom-up processes driven by people wanting to change something.

You mention a “shared responsibility” framework for sustainable development, but who bears the responsibility to use natural resources in a sustainable way? And who should bear responsibility?

Everyone should bear responsibility. If you look at the Sustainable Development Goals (SDGs) of the UN, they approach all actors. They do not just target the North or the South. They appeal to both the home and host states of investments - the private enterprises, civil society actors, the individuals, and the actors of international governance. What has not been in the discussion for a long time is that the home states of business enterprises also have a responsibility towards what their enterprises do abroad. So home states also need to adapt the regulatory framework the enterprises are embedded in.

Everything is interlinked and each actor has a role to play. Also, all kinds of regulations interact. Problems cannot be resolved by

just pointing at consumers or obviously corrupt governments. All involved actors bear responsibility.

Do you find that there is significant divergence and lack of coherence between policy-making for sustainable development and policy/goals for environmental sustainability? Are there particular reasons for divergence? Or is this perceived divergence a misunderstanding about sustainability agendas?

You always have these situations. In Switzerland currently, the environmental/climate change community is seeking money from the ODA (Overseas Development Assistance) budget that was meant to alleviate poverty and not to mitigate climate change. Instead, it would be beneficial if both communities worked together to build a strong system to create funding for transformation. These types of clashes can involve a lot of transaction costs within these communities instead of working together toward a greater good.

Do you think there is a larger role for civil society to play in the sustainability – governance arena? Or does this issue area require more legislation (state-to-state or international organization involvement that precludes the role/influence of civil society (in individual states or globally))?

Civil society organizations have a key role to play. They are powerful in “planting” new ideas and initiating change. I’m often observing, however, that civil society actors lack a certain knowledge regarding

economic governance. Take a look at what strong policy drivers are; economic, tax, investment, and trade policies, but also monetary policies of national banks as well as financial policies concerning the banking and insurance sector. Detailed knowledge related to these regimes is often not available in civil society organizations or only exists at a superficial level. However, detailed knowledge is needed to begin at the right end and perform effective work.

I would recommend strengthening the knowledge base of civil society actors by better integrating legal, economic and policy experts in these institutions. These experts may have a better understanding of mechanisms that are often not very visible, but will also need the experience of “classical” civil society actors to advance things. It is often more helpful not to reject ideas in a blunt way but to bring into the debate nuanced solutions nobody would have thought about.

Sustainability is about dealing with tricky questions, and answers are needed that may not yet have been designed. Who is developing these answers? Where do we have the fora of people who are asking the difficult questions and understand the technicalities that need to be addressed for change to occur? Many such fora will be needed across the globe in order to successfully face the complexities that come with a shift towards more sustainability.



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