Agri-Food Systems Transformation

From Strategy to Action

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Introduction

Giorgio Marrapodi

I would like to begin on a very serious point – namely, with an overview of the data that tell us that while enough food is currently produced to feed the entire world population, about 821 million people suffer from hunger or malnutrition and about 45% of infant deaths are linked to malnutrition.

Among these people, in 2019 alone, 123 million experienced food insecurity caused by crises: humanitarian, environmental, military and, very often, interconnected crises. In 2020, with the health crisis induced by Covid-19, the food supply chains failed in many countries where they are unintegrated and unable to survive external shocks, worsening the whole picture.

At the same time, 1.9 billion people – more than a quarter of the world population – are overweight, costing the global economy the equivalent of 3.5 trillion US dollars a year, and carrying an even more serious cost in human lives.

About 80% of extreme poverty in the world is concentrated in rural areas where climate change and the delay in resilience and mitigation policies aggravate the effects of food insecurity. For years now, a large literature has described the harmful effects of malnutrition on immune responses, which are unable to adequately cope with pathogens and infections, underlining how serious the problem is especially in low-income countries. And, as I have already noted, in 2020, faced with the health crisis, this situation worsened still more.

To tackle such a complex and systemic problem, the Italian Development Cooperation has been trying for years to identify the strategies and actions necessary to put an end to these dramatic numbers: for this reason, food security, proper nutrition and sustainable agricultural development are the traditional priorities of our commitment.

We employ our response in emergencies, working together with efforts by the international community to defeat the food crises in progress, which affect especially some African countries, acting urgently to save the hardest-hit populations.

However, responding to the emergency is not enough; the goal remains to create the conditions for sustainable agricultural and rural development beyond the emergency, to produce systems which are able to endure and react to future shocks, increasing the resilience of more vulnerable populations.

Italy's efforts in this sector have always been a national priority, but alone, as we well know, we can achieve only limited objectives. The synergies that we put into place in this field with the three Rome-based agencies of the United Nations, which together constitute the main global reference point for the fight against hunger and the promotion of sustainable agricultural development, permit us to amplify our range of action.

We are important financial partners of the Food and Agriculture Organization of the United Nations (FAO) and of all the agencies of the Rome-based UN hub. Ours is a strong and necessary support, but our effort goes beyond it: we take the role of a leading country in the food and nutrition sector, and export our models, which are based on significant experience in Italian agro-industrial development and are linked to the protection of the territory, to organic production, to the enhancement of local peculiarities, to the system of cooperatives, to the added value in processing and to the quality of food, which today makes for the excellence of the sector.

There is always occasion to strengthen our partnership with FAO, thanks to the leadership of Director General Qu, in order to reinforce our view of an agricultural model based on crop diversification – one which promotes biodiversity and restores ecosystems, achieving a balance that ensures long-term soil fertility.

In our work, we dedicate the utmost commitment to the promotion of sustainable agricultural supply chains, through support across the spectrum: with solid roots in science, but with a solid grounding as well in the human rights that characterize our approach to development, supporting small producers, cooperatives, the involvement of local communities and, last but not least, the enhancement of female entrepreneurship and their trade associations. I left this last point for last – but not because, as Fermat writes, "it is not contained in the narrow margin of the page".[1] I assure you, it is for us an essential part of our own "theorem": until everyone acts like human rights are women's rights and

[1] *J'en ai découvert une démonstration véritablement merveilleuse que cette marge est trop étroite pour contenir* (Pierre de Fermat, in a handwritten margin note to his personal copy of Diophantus of Alexandria's *Arithmetica*, in 1637).

women's rights are human rights, once and for all, we will not be free from poverty and hunger, either. 25 years after Hillary Clinton's assertive speech in Beijing, we must unfortunately point out that gender equality has not yet been achieved. Yet until there is true equality, which we must strive to achieve with all the tools available, our work will not be completed.

The Covid-19 emergency has once again shown the importance of resilient food chains, which are capable of reacting to external shocks and continuing their indispensable function of supplying the population.

In a year as difficult as this past one, we have promoted the Food Coalition with FAO to share with other countries our good practices of sustainable agriculture and food supply chains that can be used to create resilient and sustainable food systems and prevent serious crises, like the one we are still experiencing, from interrupting even our most basic needs, such as nutrition.

This model, which entails our view of the humanitarian/development nexus, can save millions of lives which are currently exposed to systemic crises, when they are not tragically lost due to the effects of food insecurity, and we will carry it forward in the main global events of 2020, from the G20 Italian Presidency to the Food Systems Summit in Rome and New York.

I would like to conclude by recalling that often the solutions are at hand, but we are not able to fully grasp them. So this too must be our effort: in carrying out the European *farm to fork* strategy, let us rely on science and nature, which, as the Lincei teach us, do not contradict one another. Let's work with the aim of putting an end to chronic food insecurity for almost a billion people, without moving away from the earth, from agriculture, from food linked to our culture. Most importantly, let's not uncritically turn to the production of food at scale, according to the latest fashion of *lab to fork*.

Lectio Magistralis

Qu Dongyu

The Food and Agriculture Organization of the United Nations (FAO) was established on 16 October 1945 at the first session of the newly created UN in Quebec City, Canada, with 44 nations formally joining the organization. It was the fruit of two years of hard work, which began at the Hot Springs Conference organized by US President Franklin D. Roosevelt. During the conference, the countries decided to establish a specialized agency focused on food and agriculture.

FAO took over the mandate of the Rome-based International Institute of Agriculture, whose mission was to help farmers share their knowledge and establish rural credit unions. The appointment of John Boyd Orr, a prominent British nutritionist, whose research showed the link between poverty and malnutrition, as the first Director General spoke to the mission of the organization. Specifically, the FAO charter stipulates the organization's mandate to reduce extreme poverty, eliminate hunger, improve nutrition, increase agricultural productivity and rural living standards, and contribute to global economic growth.[1]

FAO made an enormous contribution to the Green Revolution through capacity building and technology transfer. New high-yielding wheat and rice varieties developed by Norman Borlaug enabled farmers to double or triple their yields from the 1970s through mid-1990s, especially in Asia, and the Green Revolution helped save hundreds of millions of lives.[2] But it also decayed the environment through the excessive use of fertilizers and pesticides, damaging biodiversity and depleting water resources.

FAO is now working to complete the unfinished agenda of the Green Revolution to reform policies and institutions guided by

[1] FAO Charter, in *Basic Texts of the Food and Agricultural Organization*, 2017, http://www.fao.org/3/K8024E/K8024E.pdf.

[2] University of California – San Diego, "Green Revolution Saved over 100 Million Infant Lives in Developing World: Increased Global Agricultural Production Had Large and Positive Effects on Child Health", *ScienceDaily*, 17 December 2020. https://www.sciencedaily.com/releases/2020/12/201217145235.htm.

science and in line with the 2030 Agenda for Sustainable Development – a collective effort made possible only through partnerships and the generosity of the host government Italy.

A strategic foresight exercise at FAO (CSFE, Corporate Strategic Foresight Exercise) identified key current and emerging socio-economic and environmental drivers and related trends which impact agri-food systems and are in turn impacted by them through feedback effects. Some drivers (systemic [overarching] drivers) directly affect the entire agri-food systems given their high interconnectedness with both supply and demand sides, and their linkages with the global socio-economic context within which food and agricultural activities occur. Other drivers directly impact food access (food demand) and livelihoods, production and distribution processes, or the environment natural resource base supporting food and agricultural activities.

Systemic (overarching) drivers

Population dynamics and urbanization are expected to keep increasing and changing food demand. Sub-Saharan Africa and South Asia are leading these changes. In addition to population growth, other factors relative to different locations are also important (e.g. ageing in rural areas and high-income countries). Other social aspects, such as spatial location and/or gender balances, change also as a consequence of internal and international migration. A recent UN report[3] on megatrends affecting global societies and economies notes that between 2020 and 2050, the portion of people living in urban areas will shift from 53% to 70% globally. These population dynamics present interconnected implications for agri-food systems because population growth and changing structure, urbanization and food demand are closely linked. Urbanization is seen as a challenge for food and agriculture, for instance in its encroaching on fertile land. In addition, the growth of young cohorts, particularly in sub-Saharan Africa and in South Asia, raises serious concerns regarding employment opportunities and the risks of degrading the quality of jobs (remunerations, exploitation, safety) within and outside agri-food systems.

[3] UN (United Nations), *Report of the UN Economist Network for the UN 75th Anniversary: Shaping the Trends of Our Time*, 2020.

Economic growth, structural transformation and macro-economic stability are not always delivering the expected results in the inclusive economic transformation of societies. The transformation of agri-food systems is closely tied to the structural transformation of socio-economic systems at large and their macro-economic stability. Economic growth and economy-wide structural transformation are results and drivers of food and agriculture transformation processes. The World Bank[4] suggested that stronger economic growth is an important driver of poverty reduction; however, poverty reduction is only realized when the gains of economic growth are shared across social strata. Sub-Saharan Africa, for instance, despite its very high economic growth in the last two decades, still awaits substantive economic transformation. The outbreak of Covid-19 is expected to add to the already existing macro-economic imbalances of several countries, where "if the current policy stances continue, the global economy from here to 2030 will face slower growth and higher instability. As labour shares across the world continue on their decreasing path, household spending will weaken, further reducing the incentive to invest in productive activities".[5]

Cross-country interdependencies tie together agri-food systems globally, but low-income food-deficit countries (LIFDCs), Small Island developing States (SIDS) and landlocked developing countries (LLDCs) heavily depend on imports for their food needs. Other countries depend on a small number of export commodities in order to import technology, energy, financial services or healthcare equipment. This commodity-dependence makes economic systems fragile and leads to negative impacts on the lives of people. *The State of Food Security and Nutrition in the World (SOFI) 2019*[6] reports that "eighty percent of the countries (52 out of 65) with a rise in hunger during recent economic slowdowns and downturns are countries whose economies are highly dependent on primary commodities for export and/or import." Furthermore, commodity-dependency may increase the difficulty of addressing environmental and social concerns *inter alia*, because multilateral

[4] World Bank, *Poverty and Shared Prosperity 2018. Piecing Together the Poverty Puzzle,* 2018.

[5] UNCTAD, *Trade and Development Report 2019. Financing a Global Green New Deal,* 2019.

[6] FAO, IFAD, UNICEF, WFP and WHO, *The State of Food Security and Nutrition in the World (SOFI) 2019. Safeguarding against Economic Slowdowns and Downturns*, 2019.

trade agreements create uncertainties,[7] as well as potentially lead to illicit financial flows that draw resources from low-income towards high-income countries, due to weak institutions.[8] The conditions under which these interdependencies increase the resilience and sustainability of agri-food systems and economic systems in general, or force them towards commodity-dependency or other forms of dependency (technological, energy, financial, cultural, geo-political and strategic etc.), is an issue that requires further consideration, while it is hoped that as a reaction to Covid-19, selected countries and communities may move towards self-sufficiency.

Big data generation, control, use and ownership enable real-time decision-making in agriculture and food systems. However, due to the large economies of scale that exist in digital industries, digitalization of many aspects of human life, social interactions and production, including agri-food value chain processes, has resulted in a digital divide, raising concerns also about the economic benefits of big data platforms that are able to amass extraordinary amounts of information on consumer behaviour and preferences.[9] Capacities in National Statistical Systems and awareness of consumers and civil society need to be built on data harvesting, storage, management and control, to ensure country-driven independent, transparent and accountable data generation, validation and utilization processes, as well as their conversion into statistics – and this is particularly important for small countries.

Geopolitical instability and increasing impacts of conflicts, including those relating to competition over resources and energy, are a major driver of food insecurity and malnutrition.[10] SOFI 2017[11] highlights that the vast majority of chronically food-insecure and malnourished people live in countries affected by conflicts. Furthermore, research suggests that 40-60% of intrastate armed

[7] For instance, "Since carbon footprint is not in essence a physical part of products [...] the implications of the TBT [Technical Barriers to Trade] Agreement requirement for the equal treatment for imports of 'like' products remain untested", FAO (Food and Agriculture Organization), *The State of Agricultural Commodity Markets (SOCO): Agricultural Trade, Climate Change and Food Security,* 2018.

[8] Cf. SDG 16, target 4, and Joint African Union Commission (AUC), United Nations Economic Commission (ECA), *Illicit Financial Flows: why Africa Needs to "Track It! Stop It! Get It!". High Level Panel on Illicit Financial Flows*, 2014.

[9] UN Chief Executives Board for Coordination, CEB/2019/1/Add.2.

[10] The number of forcibly displaced persons in 2019 reached almost 80 million people: UNHCR, *Global Trends. Forced Displacement in 2019,* 2019.

[11] FAO, IFAD, UNICEF, WFP and WHO, *The State of Food Security and Nutrition in the World (SOFI) 2017. Building Resilience for Peace and Food Security,* 2017.

conflicts over the past 60 years have been triggered, funded, or sustained by natural resources. Conflicts reduce food availability, disrupt access to food and health care, and undermine social protection systems, and the majority of food-insecure people in many parts of the world result from conflicts. This driver, interacting with climate change, the degradation of renewable natural resources and desertification, is disrupting agricultural livelihoods and food systems. Extractive activities tend to be concentrated in rural areas that include indigenous territories and have been a recurrent reason for socio-economic and ethno-territorial conflicts. A "world in disorder", where international and national conflicts emerge and persist, is among the possible future scenarios. Agriculture and food systems would be affected by disruptions in various parts of socio-economic and environmental systems and would affect people according to their social features (gender, age, ethnicity, socio-economic status, etc.).

Uncertainties. All drivers affecting agri-food systems are subject to multiple systemic risks of hazards carrying uncertainties that often materialize in sudden occurrences. *The Future of Food and Agriculture*[12] (FOFA) highlights that the future of food and agriculture faces uncertainties that give rise to serious questions and concerns, and that these uncertainties revolve around different factors, including population growth, dietary choices, technological progress, income distribution, the state of natural resources, climate change, and the sustainability of peace. The timing, speed, geographic spread and magnitude of the outbreak of Covid-19 and its impacts is a case in point.[13] Multiple risks of disasters and crises, often combined with conflicts and other shocks, generate damage and losses. Extreme climate events such as drought, floods and storms, seasonal variabilities in weather and slow onset events such as sea-level rise are also unfolding emergencies. The 2020 desert locust upsurge together with other high-impact and transboundary food chain crises are also threatening agriculture and food systems. Uncertainties, and more specifically, their impacts on agri-food systems, are difficult to predict and measure, but prevention with risk management and anticipation, including emergency preparedness and capacity to face them, may reduce their impacts.

[12] FAO (Food and Agriculture Organization), *The Future of Food and Agriculture. Alternative Pathways to 2050*, 2018, https://www.fao.org/3/I8429EN/i8429en.pdf.

[13] FAO (Food and Agriculture Organization), *Protecting People and Animals from Disease Threats,* 2018.

Drivers directly affecting food access and livelihoods

Rural and urban poverty. Rural areas are lagging behind. Despite great potential in many instances, a high proportion of rural inhabitants live in poverty or extreme poverty. Labour income in the agricultural sector is lower than the average income of other sectors and is characterized by higher gender imbalances. Many rural territories face severe deficits in infrastructure, institutional weakness, limited access to basic services and natural resources, and an eroded social fabric. Overall, the number of food-insecure people is increasing and malnourishment is widespread, as stated in *SOFI 2020*, because the cost of a healthy diet is much higher than the international (extreme) poverty line, established at 1.90 US dollars purchasing power parity (PPP) per day,[14] and there are significant risks for the most vulnerable of falling into poverty. While the whole of Agenda 2030 is grounded on the 'Leave no one behind' principle, still certain groups within society such as the elderly, children and youth, women, as well as indigenous people, in many instances risk discrimination and marginalization. Moreover, in some instances these groups face conditions such as insecurity, violence and/or involvement in illegal economic activities which aggravate their situation. An additional issue brought about by the outbreak of Covid-19 is the disparity of access to public healthcare services, as well as other public services, within societies and across countries, topped by exacerbated pre-existing gender inequalities along many dimensions, including the increase of care and domestic work that limit women's participation in the labour market. These often unmeasured disparities may provide a more severe picture of current poverty levels, with resulting worsening of purchasing power, and consequent resorting to mere calorie consumption, thus worsening their nutritional status.

Inequalities. Societies are characterized by high inequalities in income, job opportunities, access to assets including natural resources, basic services, and fiscal burden. There are large segments of populations that are living either below the threshold, or at the edge of, poverty, while a few make very significant profits, within and outside the food and agriculture sectors. Women, girls, youth, small producers and indigenous groups suffer the most, and in ways that are not always measured because they go very far beyond

[14] FAO, IFAD, UNICEF, WFP and WHO, *The State of Food Security and Nutrition in the World (SOFI) 2020. Transforming Food Systems for Affordable Healthy Diets,* 2020.

mere economic inequalities. Increased inequality can erode social cohesion, lead to political polarization and ultimately lower economic growth.[15] Worryingly, inequality of income is growing. In Asia, for instance, despite high economic growth over the past few decades (an average annual gross domestic product, GDP, per capita growth rate of 5% from 2000 to 2016), income inequality has risen, thus slowing progress in poverty reduction, with further exacerbating inequalities due to the impact of Covid-19.

Food prices are significantly higher in recent years than they were 20-30 years ago. Indeed, food is around 30% more expensive than in the '90s, even without considering the price spikes of 2008 and 2011.[16] This occurred despite the fact that current pricing mechanisms fail to capture the whole cost of food, including social and environmental externalities at all levels (full cost accounting). FOFA 2050 highlights that if environmental costs were accounted for, food prices might significantly increase, all things being equal, by 30-35% in the next decades. While political and media attention is sensitive to the price of food, and policy makers raise concerns on the efficiency of food and agricultural systems, cheap, unhealthy, and socially and environmentally unsustainable food cannot be the solution.

Drivers directly affecting food and agricultural production and distribution processes

Innovation and science. Several technologies currently applied in agri-food systems contribute to degradation of natural resources. This is due to intensive production systems focusing on profitability over environmental aspects. Technical progress including the emergence of more "systemic" technologies, digitalization, biotechnologies and all other innovative approaches raise opportunities[17] to

[15] IMF (International Monetary Fund), *Fiscal Monitor: Tackling Inequality*, 2017.

[16] As measured by the real FAO Food Price Index (FFPI). The FFPI is a measure of the monthly change in international prices of a basket of food commodities. It consists of the average of five commodity group price indices weighted by the average export shares of each of the groups over 2014-2016.

[17] FAO advocates leveraging ecosystem services to complement these external inputs. The overuse of external inputs increases the environmental footprint of food production – too much irrigation exerts more pressure on an already scarce resource, just as too many pesticides and herbicides damage the environment, reduce biodiversity (which generate ecosystem services) and potentially are prejudicial to human health.

achieve, in concert, the dual aims of producing sufficient food and safeguarding the environment, while remaining mindful of challenges.[18] Research is ongoing into their development, limits and potential drawbacks to ensure that their safety and acceptability aspects are properly addressed, providing gender-balanced access and bringing low-income countries onboard to avoid technological divides.

Public investment in agri-food systems decreased significantly in the last 15 years, as shown by the FAO Agriculture Orientation Index (AOI) for Government Expenditures (SDG Indicator 2.a.1). In many instances, priorities set by governments, particularly those of low-income countries, including LIFDCs, SIDS, and LLDCs, are not implemented due to insufficient public investment and/or the low priority they attribute to local food systems. Thus, those countries that are currently heavily dependent on imports to cover their food needs are likely to remain such, unless they shift their priorities. In addition, adequate regulatory and legal frameworks to secure financing are limited and not conducive to attract private sector investments.

Capital/information intensity of production is increasing due to the mechanization and digitalization of production in almost all sectors, including in food and agriculture. While these trends contribute to augmenting the overall productivity, they also raise concerns for the levels of employment, both in rural and urban areas.[19] Increasing capital intensity in the downstream segments of food value chains limits labour demand in processing and distribution, all things being equal. In addition, the mechanization/digitalization of primary production lowers profits for farmers who do not or cannot appropriate new capital assets. Young farmers, possibly more inclined to adopt digital technologies and other innovations, can increase their capital ownership only if they have access to finance, training and capacity development. However, despite the fact that the progressive spread of advanced technologies is likely to increase the profitability of food-related livelihoods and create new job opportunities, the net job balance is most likely to be

[18] UN (United Nations), *UN Secretary-General's Strategy on New Technologies,* 2018.

[19] UN Economic and Social Council, E/CN.9/2020/2, *Population, Food Security, Nutrition and Sustainable Development*, 2020: "[…] the manufacturing, agrifood and service sectors are themselves undergoing capital intensification through the adoption of information technologies (robotics, digitalization and artificial intelligence) that reduce the need for workers".

negative. Thus, increasing capital/information intensity of food production, associated with ageing, may further contribute to urban migration and the emptiness of rural areas, and if employment and other earning opportunities cannot be found in urban areas, poverty and food insecurity may increase.

Market concentration of food and of agricultural inputs and outputs represents a challenge for the resilience, equitability and sustainability of agri-food systems. Unprecedented levels of market concentration throughout the global agri-food systems[20] spanning from crop seeds, agricultural chemicals, veterinary pharmaceuticals, agricultural machinery, fertilizers, livestock genetics, fishing rights, food processing and commodity trading deserve attention. Furthermore, land concentration associated to the lack of land-use regulations also affects access to resources. This puts rural, local and low-income economies at risk and increases their dependency on external actors. The Covid-19 pandemic is showing the weaknesses of such concentrations, which may require in some circumstances relying more on locally produced goods.

Consumption and nutrition patterns, resulting from a behavioural change in consumers, are key factors affecting food and agriculture systems. Consumers are increasingly making complex choices about the sustainability, nutritional content and safety of what they eat. Shifting consumer demand in the direction of sustainable and healthier eating patterns is important. Recognizing that consumers are ready to change their behaviour if correctly informed may lead to deep changes in production systems. For instance, carbon labelling could help shape consumer preferences, contributing to the transition to a low-emissions economy. This would require an internationally recognized approach in setting the related standards (FAO SOCO, 2018) and, as recalled in the *Global Sustainable Development Report*, building sustainable food systems and healthy nutrition patterns to accelerate progress towards the SDGs (Sustainable Development Goals) requires collaborative action by various stakeholders, including consumers.[21]

[20] IPES-Food, *Too Big to Feed: Exploring the Impacts of Mega-Mergers, Concentration, Concentration of Power in the Agrifood Sector*, 2017, https://www.ipes-food.org/_img/upload/files/Concentration_FullReport.pdf; UNCTAD (United Nations Conference on Trade and Development), *Trade and Development Report 2018: Power, Platforms and the Free Trade Delusion*, 2018.

[21] UN (United Nations), *Global Sustainable Development Report 2019: The Future is Now: Science for Achieving Sustainable Development*, 2019.

Drivers regarding environmental systems

Scarcity and degradation of natural resources. Land, water, soil and biodiversity are progressively degrading. Water scarcity, land degradation, soil nutrient depletion, large-scale deforestation, overexploitation of marine resources and pasture, and pollution at all levels raise serious concerns, not only for the entire agriculture and food systems, but also for the achievements of the SDGs. "Inefficient or unsustainable farming systems are often associated with environmental and soil degradation and biodiversity loss and an increase in crop specialization and distribution can raise the risk of poor harvests."[22] Availability and accessibility of natural resources per capita, including land and water, are one of the most important bottlenecks for agri-food systems. For instance, although the Asian and the Pacific region account for more than half (56%) of the world population, the region covers less than one-quarter of the global land area. Population growth, urbanization and industrialization are increasing pressure on natural resources used by the agricultural sector. In Latin America, the natural resources of the region have been degraded by the development of intensive productive activities related to agriculture and food systems. Sub-Saharan Africa is experiencing the same situation of severe degradation of natural resources, water scarcity in dryland areas of the Sahel and the Horn of Africa, as well as in Southern Africa. Massive deforestation is also occurring, linked to the extension of agricultural land, to the exploitation of mining, to infrastructure works such as hydroelectric dams or roads, to urbanization, and even to excessive logging. Competition over progressively scarce natural resources contribute to conflicts, and likewise, the agricultural sector across many regions is increasingly deeply affected by the frequency and intensity of extreme weather events.[23]

Epidemics and degradation of ecosystems, beyond Covid-19, may increase in the future due to rising trends in transboundary animal and plant diseases and pests, agriculture encroaching on wild areas and forests, antimicrobial resistance and the increasing production and consumption of animal products. According to a UNEP-ILRI

[22] UNEP (United Nations Environment Programme), *Global Environment Outlook – GEO-6: Healthy Planet, Healthy People*, 2019.

[23] Full-cost accounting of natural resource use and degradation, mentioned above, while engendering shifts in prices may have impacts on natural resource use, GHG (Greenhouse Gas) emissions and biodiversity.

report,[24] "the pathogens originate in animals, and the emergence or spillover of the diseases they cause in humans is usually the result of human actions, such as intensifying livestock production or degrading and fragmenting ecosystems, or exploiting wildlife unsustainably." All this adds to the increasing occurrences of events that threatens food safety, aggravated by climate change, and calls for a One Health approach.[25]

Climate change, due to agricultural and economy-wide greenhouse gas (GHG) emissions, is already affecting food systems, food safety and natural resources, and is expected to accelerate hunger and poverty in rural areas.[26] In Latin America, for instance, food systems will be impacted, both currently and in the medium- and long-term, by climate change. It is estimated that rain-fed production in selected areas (e.g. in the Southern Cone of Latin America) will be reduced by seasonal water stress. In addition, fisheries and aquaculture production will be affected. SIDS and coastal areas will face sea level rise, increased hurricane frequency and intensity, saline intrusion, ocean acidification and warming and increased incidence of coral bleaching. On the other hand, "an estimated 23% of total anthropogenic greenhouse gas emissions (2007-2016) derive from agriculture, forestry and other land use".[27] Not only agri-food systems contribute a large share of total global CO2-equivalent emissions, including through deforestation and other land use changes, but almost all prevailing economy-wide development paradigms are based on fossil fuels and huge GHG emissions.[28] Overall, there are no risk-informed measures to tackle a warming planet

[24] UNEP (United Nations Environment Programme) and ILRI (International Livestock Research Institute), *Preventing the Next Pandemic: Zoonotic Diseases and how to Break the Chain of Transmission,* 2020.

[25] WHO (World Health Organization) One Health approach to designing and implementing programmes, policies, legislation and research requires that multiple sectors work together to achieve better public health outcomes such as food safety, the control of zoonoses (diseases that can spread between animals and humans, such as flu, rabies and Rift Valley Fever), and combatting antibiotic resistance of bacteria.

[26] Regarding the impact on food safety, see for instance: FAO (Food and Agriculture Organization), *Climate Change: Unpacking the Burden of Food Safety*, Rome, 2020, https://www.fao.org/3/ ca8185en/CA8185EN.pdf.

[27] IPCC (Intergovernmental Panel on Climate Change), *Special Report on Climate Change, Desertification, land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems,* 2019.

[28] This also applies to some activities that are increasingly portrayed as complementary to agricultural activities in rural areas such as tourism, whose GHG footprint has largely to be investigated.

beyond a 1.5 degree scenario, and there is limited understanding of the implications of deep decarbonization. Vision and knowledge about these issues is particularly important for the post-Covid recovery process that, it is assumed, will "build back better".

The "Blue Economy", that is the development of economic activities related to oceans and coastal areas, is increasing globally, and increasingly the concept around which countries (particularly SIDS and other states that enjoy large Exclusive Economic Zones, or EEZ) build their economic development policies. A recent IPCC report[29] highlights an important role for sustainable ocean industries to reduce GHG emissions and adapt to climate change. At the same time, while aquaculture is expected to provide the necessary increase in aquatic products globally, its regional development is uneven and hampered by constraints which need to be adequately addressed through better governance, increased investment, and targeted support of environmentally friendly production systems such as integrated multi-trophic aquaculture in coastal areas and integrated agriculture-aquaculture in inland regions, with a special focus on Africa which is the only region foreseen to have declining "apparent consumption".[30] Aquatic food production systems are nested in the larger development framework. However, many "blue economy" policies favour large projects such as oil/gas and shipping/ports or even tourism, which bring economic benefits, but also environmental degradation, with impacts on food from the ocean and ocean biodiversity. Arising trade-offs require further investigation for risk-informed, sound policy-making and investments for resilient and sustainable development.

Current agri-food systems are failing. They are not delivering the food security and nutrition outcomes that countries aim to achieve by 2030. They are also creating vicious feedback loops that are harmful to health, the economy and the planet.

For starters, the world is not on track to ending hunger.[31] The number of hungry people in the world has continued to rise. Almost 690 million people went hungry around the world in 2019,

[29] IPCC (Intergovernmental Panel on Climate Change), *Special Report on the Ocean and Cryosphere in a Changing Climate,* 2019.

[30] Apparent consumption is a proxy measure for consumption of a product or material defined as production plus imports minus exports of the product or material (UN Stats Glossary).

[31] FAO, IFAD, UNICEF, WFP and WHO, *The State of Food Security and Nutrition in the World (SOFI) 2020*, *Key Messages*, 2020, https://www.fao.org/3/ca9692en/online/ca9692en.html#chapter-Key_message.

an increase of 10 million over 2018. During the five years before that, the ranks of the hungry swelled by 60 million. The coronavirus pandemic is estimated to have pushed an additional 83-132 million into chronic hunger in 2020. Additionally, 2 billion people globally don't have regular access to safe, nutritious and sufficient food. If recent trends continue, the number of people affected by hunger will surpass 840 million by 2030.

The world is also not on track to defeating malnutrition.[32] Despite some progress, child stunting remains unacceptably high. In 2019, over 21% (144 million) of children under 5 years of age were stunted, and almost 7% (47 million) were wasted. Child overweight is also not improving, with about 38 million, or 5.6%, of children being overweight. Adult overweight and obesity are also on the rise in rich and poor countries alike. The number of people living with obesity exceeded that of people in hunger in 2012. And more than 3 billion people globally cannot afford a healthy diet.

Our dietary choices and agri-food systems have dire consequences not only on health. They inflict significant environmental damage, including staggering levels of food loss and food waste, air pollution, greenhouse gas emissions, and loss of biodiversity. They are also a growing source of inequality.

Understanding these hidden costs is critical for making progress in other Sustainable Development Goals.[33]

By 2030, undernourishment must fall everywhere to a maximum of 5%. Healthy diets must be affordable for all. Overweight has to be cut everywhere to 15% or lower, similar to what it was in the 1980s. In every country, obesity needs to fall to no more than 5%. Stunting among children must be reduced significantly. The lost decade in rural poverty reduction needs to be recovered. In order to cut rural poverty, inequality must be addressed. Finally, the world has to meet the Paris agreement target of limiting global warming to less than 2°C.

Agri-food systems are the largest economic system, measured in terms of employment, livelihoods and planetary impact. They employ 4 billion people, directly and indirectly. Poverty and inequality are endemic in agri-food systems. As stated earlier, 690 million people go to bed hungry every night, even though the world produces enough food for everyone. About 80% of the extreme poor live in rural areas, working in agri-food systems.

[32] Ibid.
[33] Ibid.

To achieve our food security and nutrition goals, it is important to approach the challenges in a systems-based way, adopting a holistic view. That means recognizing the interconnectedness of the economic, social and environmental impacts of our agri-food systems, looking for synergies and trade-offs in policy solutions. Evidence must guide how to prioritize policy actions and investments.

The pay-off of doing this can be tremendous, including an array of solutions to reduce our carbon foodprint and ensure environmental sustainability, while making healthy foods more affordable for everyone and addressing inequality. A systems-based approach could also help policymakers manage trade-offs. For example, some low- and lower-middle income countries may need to increase their carbon footprints in order to meet the dietary needs of their populations, particularly to prevent malnutrition.

Making agri-food systems more inclusive, sustainable and resilient will go a long way toward ending hunger and malnutrition.

Agri-food systems are the major driver of climate change and the planet's unfolding environmental crisis.[34] Agriculture uses about 40% of the Earth's land and emits more greenhouse gases than all cars, trucks, trains, and aeroplanes combined. Runoff from fertilizers pollutes waterways and coastal ecosystems. Agriculture also consumes 70% of all freshwater on Earth. And it causes approximately 80% of forest loss.

The coronavirus pandemic is a wake-up call on the urgent need to transform agri-food systems. This is because Covid-19 and climate change are intimately linked. Covid-19 and other diseases are rooted in environmental change. 60% of all infectious diseases are zoonotic, and 75% of all emerging diseases are zoonotic.[35]

Food systems have contributed to substantial biodiversity loss, even though biodiversity is indispensable to food security. It supplies many vital ecosystem services, such as maintaining healthy soils, pollinating plants, controlling pests and providing habitat for wildlife – for fish and other species that are vital to food production.[36]

[34] UN (United Nations), *Policy Brief: The Impact of COVID-19 on Food Security and Nutrition*, June 2020, https://www.un.org/sites/un2.un.org/files/sg_policy_brief_on_covid_impact_on_food_security.pdf.

[35] UNDP (UN Development Programme), *Coinciding Crises: how COVID-19 and Climate Change Are Putting Pressure on Health Systems Worldwide – and How we Can Prepare for the Future*, 2020, https://reliefweb.int/report/world/coinciding-crises-how-covid-19-and-climate-change-are-putting-pressure-health-systems.

[36] FAO (Food and Agriculture Organization), *The State of the World's Biodiversity for Food and Agriculture*, 2019, http://www.fao.org/state-of-biodiversity-for-food-agriculture/en/.

It should raise the alarm that key components of biodiversity for food and agriculture are declining. Humans have fundamentally altered 75% of the Earth's land surface.[37] Around 1 million animal and plant species are threatened with extinction.[38] About 66% of the ocean area is experiencing multiple impacts from people, including from fisheries, pollution, and chemical changes from acidification. Nearly a third of fish stocks are overfished.

Deforestation and forest degradation continue to take place at alarming rates.[39] This is of course resulting in significant loss of biodiversity. Forests cover 31% of the global land area. And the proportion of land covered by forests is decreasing. In the last 30 years, the world lost 178 million hectares of forest, an area about the size of Libya. Since 1990, an estimated 420 million hectares of forest has been lost through deforestation. While the rate of deforestation is going down, the world is still losing an area of forest the size of Italy every 3 years.

Forests remove about one third of the fossil fuel emissions every year. So the loss of forests means not only a loss of resources and products forests provide for humans, plants and animals, but also not being able to meet the global climate goals. If deforestation is halted and degraded forests are restored, it can provide up to one third of climate mitigation needed between now and 2030 to stabilize global warming to below 2°C.[40]

Agricultural expansion is the main driver of deforestation and the associated loss of forest biodiversity. So to stop deforestation and the loss of biodiversity, agri-food systems must change.

FAO's Strategic Framework seeks to support the 2030 Agenda through sustainable, inclusive and resilient agri-food systems for better production, better nutrition, a better environment, and a better life.

The four "betters" represent an organizing principle for how FAO intends to contribute directly to SDG 1 (no poverty), SDG 2

[37] UN (United Nations), *First Person: COVID-19 is not a Silver Lining for the Climate, Says UN Environment Chief*, 5 April 2020, https://news.un.org/en/story/2020/04/1061082.

[38] IPBES (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services), *The Global Assessment Report on Biodiversity and Ecosystem Services. Summary for Policymakers*, 2019, https://ipbes.net/sites/default/files/2020-02/ipbes_global_assessment_report_summary_for_policymakers_en.pdf.

[39] FAO (Food and Agriculture Organization), *The State of the World's Forests*, 2020, *Key Messages*, https://www.fao.org/3/ca8642en/online/ca8642en. html#chapter-Key_message.

[40] Ibid.

(zero hunger), SDG 10 (reduced inequalities), and to achieve the broader SDG agenda, which is crucial for achieving FAO's overall vision. The "betters" reflect the interconnected economic, social and environmental dimensions of agri-food systems. As such, they also encourage a strategic and systems-oriented approach within all FAO interventions.

In order to maximize efforts in meeting the SDGs and to accomplish the organization's aspirations – the four betters – FAO will apply four cross-cutting/cross-sectional "accelerators": technology, innovation, data and complements (governance, human capital, and institutions) in all of its programmatic interventions.

Emerging technologies are already changing the food and agriculture sector. Helping farmers take full advantage of new technologies such as digital agriculture, biotechnologies, precision agriculture, innovations in agroecology, 5G, and Artificial Intelligence can increase food production, while minimizing the environmental footprint. For example, accelerators can help reduce physical inputs and improve or optimize their use. Digital tools – from e-commerce and blockchain transaction ledge to improved pest control and crop genetics using AI – can optimize natural resources and enhance food security.

Innovation in agriculture is a driving force for achieving a world free from hunger and malnutrition. Social innovations, policy innovations, institutional innovations, financial innovations, and technological innovations are important drivers affecting food and agricultural production and distribution processes.

FAO's geospatial platform and the big data lab exemplify how data on food, agriculture, socio-economics, and natural resources can come together to help strengthen evidence-based decision-making in the food and agriculture sectors. Data can enable monitoring of agricultural water productivity, allowing the design of targeted agricultural interventions and investment plans through a territorial approach which fosters inclusion and sustainable food and nutrition security.

Complements refer to the needed governance, human capital and institutions that can ensure agri-food systems transformation is inclusive and equitable. It is critical that technology, innovations and data are inclusive and gender-sensitive, and are used to spur development. Transformative processes require as a precondition much stronger, more transparent and accountable institutions and governance, including adaptive and effective regulatory governance.

As technologies revolutionize, the risks of unequal access and exclusion loom. Investments in human capital by building capacities, as well as policy and regulations minimizing such risks are

required. It is imperative that the labour supply respond to the new labour demand that will result from the new technologies and innovation to make the process more inclusive. Technologies have to be affordable, so that everyone can access them. Other structural barriers, including lack of education and training, must be identified and addressed.

FAO has prioritized 20 programme priority areas around the *four betters* of the new strategic narrative.

• *Better Production* means ensuring efficient, sustainable consumption and production patterns through sustainable and inclusive supply chains to boost food systems resilience. Priority areas include green innovation, blue transformation, one health, small-scale producers' equitable access to resources and digital agriculture.

• *Better Nutrition* means ending hunger, achieving food security and improving nutrition. Priority areas include healthy diets for all, nutrition for the most vulnerable, safe food for everyone, reducing food loss and waste and transparent markets and trade.

• *Better Environment* means protecting, restoring and promoting sustainable use of terrestrial and marine ecosystems, promoting a good environment for farming systems, and combating climate change through sustainable, inclusive and resilient agri-food systems. Priority areas include climate mitigating and adapted agri-food systems, bio-economy for sustainable food and agriculture, and biodiversity and ecosystem services for food and agriculture.

• All of the above contribute to *Better Life*. This means promoting inclusive economic growth by eliminating hunger, improving the life of vulnerable people, reducing inequalities, and improving quality of life in urban and rural areas. Priority areas include gender equality and rural women's empowerment, inclusive rural transformation, sustainable urban food systems, agriculture and food emergencies, and resilient agri-food systems. Scaling-up investment and the Hand-in-Hand Initiative focus on ensuring that collective action towards SDG achievement can be scaled to trigger transformational change in agri-food systems.

Cross-cutting themes around gender, youth and inclusion will ensure that FAO does not lose sight of vulnerable and marginalized groups in its work. FAO is deeply committed to leaving no one behind and contributing to the attainment of SDGs 1, 2 and 10.

Finally, as previously mentioned, FAO will apply the accelerators – technology, innovation, data and complements (governance, human capital and institutions) – in all its programmatic interventions to speed up progress and minimize trade-offs.

The following showcases FAO's programme priority areas around the betters.

Digitalization

FAO proposes the development of "1,000 Digital Villages", focusing on digital technologies to improve production and agribusiness management as well as market-oriented agricultural processes.

• From the perspective of agricultural production, it refers to "e-Agriculture." It focuses on improving productivity by using Information and Communications Technologies, as well as other digital solutions. Examples: climate-smart agriculture, precision agriculture, intelligent facility agriculture.

• From the perspective of farmer's livelihood, it refers to "Digital Farmer Services". It focuses on enhancing farmers' access to financial services, social protection and insurance. Examples: digital finance, fintech, digital agricultural insurance schemes and farm registries.

• From the perspective of the village, it refers to digital services that can support "Rural transformation". It focuses on enhancing the delivery of public services in health, education, jobs, welfare, eco-tourism and agri-tourism.

Transformation through aquaculture

Capture fisheries peaked in the mid-1990s. They have since remained remarkably constant, regional variations notwithstanding. At the same time, aquaculture – an old production industry – started to grow, and it now matches capture fisheries in volume.

FAO has projected three future scenarios for both sectors: a high-road scenario, a low-road scenario, and business-as-usual scenario. There is a difference of 110 metric tonnes between a high-road and a low-road scenario. "Blue transformation" can take fishermen to the high-road scenario. There is a gap between sustainable intensification of aquaculture (where food is needed most) and transformative fisheries management (where sustainability is under threat). Blue transformation can fill this gap by 2050.

Fish are more efficient at converting protein than terrestrial livestock. This is because they expend less energy on maintaining bodily processes than terrestrial livestock do. So they outpace chicken, pork and beef in their efficiency. One kg of fish will provide 1 kg of feed; with beef, it would be 150 g of feed, with pork 280 g of feed. Even though fish is an excellent source of food to address micronutrient deficiencies, especially in pregnant women and children under 5 years of age, it wasn't until 2014 that the

role fish can play in eliminating hunger and malnutrition was recognized by the Committee on World Food Security.

Sustainable urban and rural development

FAO launched the Green Cities Initiative to improve the urban environment, strengthen urban-rural linkages and boost cities' resilience, services and populations against shocks, like climate change and the coronavirus pandemic. The initiative builds on FAO experience of integrating agriculture, forestry, fisheries, and sustainable food systems in urban and peri-urban settings. The main objective is to increase people's well-being through better access to improved products and services provided by urban and peri-urban forestry, agriculture and food systems. The initiative will be implemented in at least 100 cities around the globe in the next three years; 1,000 cities are expected to join by 2030.

FAO launched the Hand-in-Hand Initiative to accelerate agricultural transformation and sustainable rural development to end poverty, hunger and all forms of malnutrition. It is a country-led, country-owned programme to eradicate poverty and end hunger and malnutrition. It uses integrated geospatial, bio-physical and socio-economic analysis to identify territories where agricultural and rural transformation can have maximum impact within a 6- to 8-year timeframe. The programme supports countries that have limited capacities for sustaining such processes on their own, including those facing serious food crises. Currently, 34 countries have signed on.

Discussion*

Qu Dongyu, Joachim von Braun, Giorgio Parisi,
and Wolfango Plastino

Wolfango Plastino: *According to State of Food Security and Nutrition in the World (SOFI) Report 2020, three billion people can't afford healthy diets today; what changes are needed to increase access to healthy diets and to assure at the same time sustainable agri-food systems?*

Joachim von Braun: Before answering this question, first let me define healthy diet. It is a diet that is human-health promoting and disease-preventing by providing adequacy of nutrients, without excess, from foods that are nutritious and healthy, and avoiding the introduction of health-harming substances anywhere in the value chain. Healthy diets must also be accessible and affordable and culturally acceptable.

So what changes are needed to increase access to healthy diets and to ensure at the same time a sustainable agri-food system? This is a complex modelling issue. We are addressing it for the Food Systems Summit in cooperation with FAO, because we need to assess synergies and trade-offs. I have four quick points to make. People need to have the purchasing power to buy a healthy diet. The poverty line postulated by the World Bank needs to be higher. 1.90 US dollars a day does not buy a healthy diet. Poorer people need social safety nets to ensure their access. Secondly, the food industry needs to be part of this, and it needs to produce healthy food. Governments need to regulate for safe and healthy food. Consumer information needs to be sound and labelling understandable. Third, there needs to be direct action for children to have access to healthy diets. School lunches and early childhood feeding at health and nutrition centres need to be expanded and better funded to have broader coverage of lower-income children, especially under Covid-19 conditions. And fourth, for sustainable food systems, food prices must

* The text below is the full transcript of the Round Table that followed the *Lectio Magistralis* by H.E. Qu Dongyu, Director General of the Food and Agriculture Organization of the United Nations.

reflect the true cost of healthy food. So-called externalities must be internalized, farming needs the incentives to become climate-neutral and shift to more sustainable land use. Food losses must be cut by means of technologies, and food waste by incentives and behavioural change targetted at consumers.

So your simple question requires a complex answer. We need to follow up on it.

Giorgio Parisi: Producing a healthy diet is not simple. So many different aspects must be considered, aspects which are not only scientific but also socio-economic, because it is one thing to know what should be done, and it is another to have other people do it, and to implement it on the field. Many aspects should be considered, but I would like to stress one, which I believe is very important, and that is biodiversity.

Biodiversity is crucial, because it has many different positive effects. Biodiversity is an insurance against bad harvests. I mean that one food crop may be destroyed by a pest, while another one may survive. Other crops can compensate for the one that is destroyed by adversity. Biodiversity also allows for food diversity, both daily and seasonally. For technical reasons, the diversity of crops allows the soil to regenerate, and micro-organisms can adapt to the great difference of compounds over time, making it more difficult for pests and other organisms to multiply. Agriculture and related land use, of course, accounts for something like 17% or 19% of the total CO2 emissions, and the transport costs may also be very high for easily degradable goods like fruit and vegetables. I think that while monocultures seem to be economically viable, they must be strongly discouraged.

Qu Dongyu: I fully agree with Professor von Braun and President Parisi, but I just want to highlight Professor von Braun's points. I respect him because, you know, we need a developed economy. If you don't develop a country which is neither big nor rich, you will create a lot of social problems in time. So, we need development and the creation of jobs, decent jobs for the farmers and the people, so they have money to buy their homes. That's the incentive. No matter whether it's food-intensive agriculture or fashion shows, fashion design or industry, or something else, we need to create jobs for development.

Second, we need innovation to improve efficiency, productivity. It doesn't matter whether it's a biotic or an abiotic approach or an engineering approach, because we're talking about biological sectors, biotechnological sectors. And so we need engineering, too. I

visited some Italian factories many years ago. You have very good machines for horticulture, for trimming the garden and so on. All these agricultural sectors are related to technology and innovations. We need innovation to improve jobs and incomes. And last but not least, we need an enabling policy to look at all the issues, like those that President Parisi mentioned, such as how to have farmers and local communities make use of biodiversity and transform biodiversity into food diversity. You can only protect your food, your biodiversity, through food diversities *in situ*. We even have a professional word for this: *in situ*. So you have one village protecting its native flowers, vegetables, fruit. I visited some small villages in Italy many years ago. Each has its special fruit, its special vegetables. And that's your national gene bank, your national germplasm.

So you can let your farmers grow, making food for other consumers for generations to come. Otherwise you're only talking about biodiversity protection. That's not very relevant to our daily life; it's only relevant to the experts. It's not good enough. So I think of these three aspects – enabling policy by putting the durables first, decent jobs in bio-agriculture, and the food industry and so on – and I think of the digital also. In China, we have 60 million new digital jobs created in e-commerce. So you lose jobs from the department store, from supermarkets, but at the same time you create new jobs in e-commerce. Direct service. These are real transformations through innovation. And that is the final point: innovation. Innovation in all things, not only technology, but business models, policy and so on.

Wolfango Plastino: *How do we use science and innovation to transform agri-food systems to achieve the 2030 Agenda for Sustainable Development Goal 2: Zero Hunger?*

Qu Dongyu: First, zero hunger: what does zero hunger mean? For different regions, for different peoples, there are different interpretations. I would say that the staple food in Africa is cassava. In Asia, South Asia, it's rice. In the South Pacific islands, it is taro, and in the Caribbean region it is a legume, or pulses. So we have the first thing to focus on: first, there are major commodities of the zero-hunger staple food. Second, we have to look at how to improve the nutritiousness of food. In Italy, you like to eat different vegetables than those that we like to eat. You like to eat eggplant, but not many countries like to eat eggplant. So you have to focus on your specific commodities. Third, to end global hunger, you have to establish a good supply chain, because in the culture of

perishable products, you need both the culture and the supply chain running. So you need to invest in the infrastructure surrounding agriculture. And fourth, you need innovation again, because, as I've said, innovation is needed in each commodity, each sector, each sub-sector. You need a different specific innovation for each of these. Otherwise, you can't feed the populace.

Joachim von Braun: Science in all key components of the food system is needed. The primary production system in the market and processing system, in consumption and nutrition, and addressing the income and resiliency issues related to climate stress. And science is needed that embraces the system as a whole – system science.

Current investment in public science for the food system is not sufficient to achieve the 2030 Agenda for hunger and nutrition. The ratio of science investment per capita in high-income countries versus low-income countries is about one hundred to one. That is one of the biggest inequalities on Earth. And we need more sharing of science – more investments and more sharing of relevant science between North and South. Investment in agricultural research for innovations is one of the highest pay-offs in terms of sustainable hunger reduction. When we scientists call for more investment in science, and more science, and so on, policy makers don't immediately believe that there is need for this. So we need to prove it. Research shows that with investment costs per person of 30-40 US dollars, about three hundred million people can be brought out of hunger productively and sustainably, if well targeted.

We need in addition better science and policy interface. Climate policy and climate science were helped forward by the international Intergovernmental Panel on Climate Change, the IPCC. We need something like that for food also, an IP on food. Maybe FAO can host it.

Giorgio Parisi: I fully agree with Director Qu and Professor von Braun. I think that science has a great responsibility here. Of course, it's not only science. We have to organize things on a global level. I think that there should be some global investment made by the rich countries in such a way that the investments of rich countries go to third-world countries, to the poorest countries, in order to help them. The total budget of FAO is something less than one billion dollars, which is not a lot if we consider the incredible kinds of problems our world is facing. It is clear that multilateralism and collaboration of countries are required to provide the possibility of having science, and innovation coming from

science, go and work in the field – to work *in situ* as Director Qu was saying. And science of course can only say to politicians what should be done; their answer on all levels, or their decision to adopt specific suggested courses, depends very much on their prior political commitments. The Green Revolution that Director Qu has spoken of before, of the fifties and the sixties, piloted new varieties of wheat, rice and maize. There were various successes in Mexico, in many Asian countries, as in India, the Philippines and China, where politicians committed to their widespread adoption, but there were fewer in Africa.

And there is another point that is quite important, one where science could be very relevant, and that is protection from pests, from all kinds of pests. For example, we know that a long time ago, I mean thirty years ago, science was quite useful in blocking the case of the cassava mealybug, which could potentially have destroyed agriculture almost completely in many African countries. The very important introduction of a parasitoid, *Apoanagyrus lopezi*, enabled control of the pest, and avoided widespread famine across sub-Saharan Africa, practically saving the lives of twenty million people. It is clear that this was a very successful intervention, but science should be very careful in monitoring this type of new parasite that could destroy agriculture, also because in some cases it could be extremely difficult to find a way to biologically control new parasites.

Wolfango Plastino: *Do we have to choose between agro-ecology and biotechnology?*

Giorgio Parisi: Well, no. I don't think we have to choose. I think that agro-ecology and biotechnology are complementary to one another. I would say that the main aim of agro-ecology is to reduce the use of synthetic chemicals, which in the long run have harmful consequences for human health, and even more importantly, we should make agricultural production sustainable, and chemical use may sometimes take us in the wrong direction. Biotechnology allows us to take fundamental steps in the same direction as agro-ecology, and there are many ways in which biotechnologies may help.

I will give only one example. Soil, which is of course the basis of any crop, is quite a complex system containing many organic and inorganic components, which coexist in close interaction with the living biomass. Of course, the system is complex because the number of different species, the number of different substances and so on, is so high that their interactions are not so easily understood, in the same way that we don't understand what happens

in our guts, where we have a hundred thousand different microbiota. Now, there are many bacteria that promote cell growth, and among these bacteria, the role of rhizobacteria is fundamental – for example, Rhizobia, which are very important because they can establish a symbiosis with leguminous plants for nitrogen fixation in the soil. It is clear that nitrogen fixation is crucial, because this is the basis of all agriculture, and all types of crop rotation. It is clear that if we succeed in certain interventions in the composition of soil micro-organisms in such a way that we can improve nitrogen fixation and other types of beneficial processes, this kind of scientific intervention, which could be done in such a way that it could be easily used, could have a dramatic effect on the productivity, and also on the sustainability, of agriculture.What is important is what happens in the long run; we should not only succeed in eradicating hunger in 2030, but we should also find a way of maintaining a world free of hunger; the sustainability of agriculture is crucial here. Now, these kinds of interventions on bacteria and other kinds of interventions of the same type are absolutely compatible with the agro-ecological vision, so I do not see any kind of contradiction between these two ideas.

Qu Dongyu: I fully agree with President Parisi, but I want to make two short comments. You know, every technology, every approach, has a main purpose, a main function. So first, I want to be clear: there is no contradiction between agro-ecology and biotechnology. They should play complementary roles. I agree with President Parisi.

Second, what kind of agro-ecological tradition are we talking about? In China, in Roman times, two thousand, three thousand years ago, in Egypt, they already had agro-ecology. But that's a low-level tradition. Now we need more innovation in agro-ecology. Innovation should come in all ideas, not only the technological stuff, but also management, and also in our marketing approach. And then we have to look out for bad technology, also. We need to minimize negative fossil fuel impact before these technologies come to the field. So there's no contradiction here.

But how can we put all of this together to make one plus one larger than two? Or even two times two makes four, or three times three makes nine. It's simple. Different countries have different priorities. Some countries may put more priority on agriculture, some maybe put more on agro-ecology or other technologies. So let's be flexible, and differentiate the priorities and the choices of the member countries, because they are in different development stages in their economies and agri-food systems.

Joachim von Braun: I want to follow up on President Parisi's point regarding soils. I very much agree that this is critical. Land and soil degradation is a big global problem. In our research, my institute together with our partners estimate that three hundred billion dollars is the annual cost of land and soil degradation. And most of this cost is lost in ecosystems functions, in water and biodiversity and so on, and also a large part is lost in production. The cost of inaction, of our accepting this high cost, is much higher than the cost of action. There are solutions, and agro-ecological approaches are part of the solutions. All agricultural systems must consider ecology; that was also highlighted by Ambassador Marrapodi. However, we must start by improving from where the systems are, that is from the realities of farming in the highly diverse farming systems around the world, and identify best-fit approaches, not idealizing approaches across the board.

Many agro-ecology approaches exist alongside many biotechnology approaches; so best fit is what we need to look for. With the exception of low-input low-output, farming will waste land resources, and we need to watch that. For instance, most smaller farmers in Africa would benefit from improved seed breeding. That breeding should be done much more locally and can be enhanced by bioscience. So the two approaches belong together.

Wolfango Plastino: *Is there one game changer solution or should we be thinking on bundling solutions to achieve the needed agri-food systems transformation?*

Joachim von Braun: There is no silver bullet to end the problems of the food systems. We have analyzed a whole range of options and concluded that a bundle of about twenty interventions in combination could go a long way towards optimally and sustainably ending hunger by 2030, or bringing it close to or below 3% from the current about 10%. That is not free of charge. At an additional cost per annum of about forty to fifty billion US dollars, we can collectively partnership between the global North and the global South, and, with a lot of actions by public and private players, achieve a world coming close to ending hunger.

For the Food Systems Summit, we are carefully modelling scenarios adapted to local circumstances, and considering options that quickly achieve both improve food and nutrition security, and protect and rebuild the agro-environment. Where should this additional annual investment of forty to fifty billion US dollars to end hunger come from? Through broad-based investment, not a

single game-changer; these resources should not only come from development aid and public investment, but also from creative financing, which needs to be mobilized. Trillions of dollars of funds are looking for investment in the low-interest-rate context currently, while there is a huge need to invest in hungry people, people with potential. This is an economic market failure and an ethical failure that the Food Systems Summit must address.

Giorgio Parisi: I agree with Professor von Braun. I also think that there is not only one game-changing solution. We actually need a bundling solution, because the transformation that we face is a slow but continuous process that requires time, but also perseverance and balance. There can be no single answer, but rather a range of answers to be adapted to different situations in different regions of the world and in different areas within the same country. There are great differences between agrifood systems in both food security, which is extremely important, and nutritional status. There are major differences in nutrition even between population strata within the same country, and eating habits change as per capita income rises. There is no one-size-fits-all solution to achieve a healthy diet and exploit the potential of the environment.

Many factors also need to be considered, such as food prices, the income of farmers, especially small farmers, the distance between production and consumption sites, and the priorities of governmental objectives in the agricultural system (because it is also important what local governments want to do); and one also has to consider finally the availability of products in local supermarkets and markets. So all kinds of economic factors have to be taken into consideration in order to go in this direction, but always recalling that the process is slow and cannot be solved with a silver bullet.

Qu Dongyu: First of all, I agree with my colleagues. But I just wanted to remind our audience that the agri-food system is not as simple as you might imagine. You eat food; every day you eat it. But this food is composed of chemistry, physics, mathematics, biology – you name it – from the soil to the water to the air. So it's not that simple, if you are not an expert in food systems. And agrifood is important not only for the time being, but for generations and generations to come, because this is part of civilization.

That's why I would like to look at the complexity of agri-food systems. We need to look at the level of scientific innovation, we need to look at the economic level, we need to look at the environmental level, we need to look at the educational aspect, we need to look even at the family level, the individual level. It's like a big

player playing a piano. You are each one of the fingers; you can play your specific role. So you may not work in the agri-food system, but you still can play a role, starting with your family, for instance by educating your grandchildren to waste less food, or by building good habits – how to purchase the hard work of farmers, and from producers and traders and so on.

But I have an idea which is a little different from the others'; we can use one stone to hit three birds. That is a government policy-maker's thinking, to use one stone to hit three birds, instead of one bird or two birds. That's the beauty of enabling policies. That's also a big potential internationally, with FAO working for one hundred and ninety four countries. I forgot to mention investing in farming development not only in Germany or China or the United States or Europe; you should go to the field. So we need more agents that understand this within the market, via market-oriented scientists in developing nations. Not only by talking in Rome; we also need to go to Africa, to the Caribbean, Latin America, and other developing nations. So let's work together, let's think together, and, by learning together, walk together and contribute together to a safe, peaceful world.

Wolfango Plastino: *What do you expect to be the role of digital technologies in the agri-food system transformation by 2030?*

Qu Dongyu: You know, in the history of the Roman times, or ancient Chinese or Asian times, we have faced three or four different stages of civilization, from traditional wild life, to the traditional home life, then you come to industrial life. Now comes digital life. You can see that the pandemic has forced us to be placeless. Placeless life, virtual life, is really green life. Of course we need face-to-face talks in the future. Still, this will be a good adjustment for us: digital culture, no matter if you're a big farmer in Brazil or in North America, or a small one in the Far East, Japan, South Korea, China (some parts of China). As I said, the digital approach will be one stone hitting three birds, or four birds, at the same time. You can force a reversal in over-production processes and supplies, and food loss or waste.

And then there is food diversity. If you come to Beijing, I don't know how to make the typical Italian spaghetti or pizza. But I can order it. If you arrive at 6:00 pm, I'll order it for half an hour later. So that's sharing cost, sharing economy, from farm production to consumption. And it also ritualizes all the small components of the process. That's what I wanted to make clear.

Every small-hold farmers in Italy can directly sell your olive oil to the market in the Far East, in Japan or in China, and there you can benefit. Through the traditional wholesaler-retailer systems, there is a lot of food and environmental waste, and also less efficiency, and farmers don't benefit from that. But it's different if you have a direct e-commerce, C2C, C2B, you name it. And also you really improve quality, because you don't need the long-term go-between. Everything is synced. We unleash potentials for the economy, for the shared economy in the world – especially for agricultural commodities.

Joachim von Braun: Director General Qu Dongyu already addressed an excellent set of issues in his lecture. The future of digital technologies in the agri-food system looks bright, but we're not there yet. Inequalities are large. Rural people and farmers need digital access. This becomes very obvious under the current Covid-19 situation. We had a conference in the Pontificate Academy of Science a couple of years ago with a distinguished Italian policy-maker, Romano Prodi, on connectivity as a human right. A human right. Some people were wondering what we were up to. Today it has become clear, thanks to Covid-19, that if rural areas don't have connectivity, their human rights are being violated.

But we don't only need connectivity, we also need the capability to use digital access, and the content needs to be useful. Digital technologies will be great for monitoring fields and animals, and the market platforms just mentioned by Qu Dongyu. Field robots can facilitate crop diversity in fields and help overcome monocultures and mechanically assist in weed control. These are things that will happen in the future; they're currently in an advanced experimental stage. The food processing industry in emerging economies, too, will become more automated, because that leads to safer food production. But that will impact labour markets. We need to consider the labour market effects of digitalization, and invest more, a lot more, in training the youth.

In conclusion, in the future, digital innovations and artificial intelligence will increasingly interact with bioscience, so the digital and the bio will come together. That can revolutionize farming on the fields and indoor farming in megacities, say for vegetables, and it will facilitate a more sustainable food system in a circular sustainable bio-economy.

Giorgio Parisi: I fully agree with the previous two distinguished speakers. One must be careful, because the introduction of digital technology is in some sense an on-going revolution, and if we do

not pay enough attention, we risk seeing only the tip of this revolution. In this sector, there is a danger that the technology will be ahead of planning, because there are things that happen that we do not control. There are a very high number of possible innovations in the agricultural system. Some of them which might be extremely interesting include the feeding of each animal according to the quantity and quality of the meat produced, of its daily weight gain; irrigation with different quantities of agro-pharmaceuticals for different areas in the cultivated fields; and semi-automatic tractor driving.

But another aspect which is very important is food quality, food safety, and this is essentially to trace products along the food supply chain, documenting where they come from, how they were grown and treated after harvesting. However, the massive use of digital technology can be achieved only if it can be used in a user-friendly way by farmers. Of course, this requires the ability to understand technology and use technology, and this might be not very easy at all in many different regions.

Also, there are some cultural and economic aspects that have to be considered; for example, special attention must be paid to small farmers who, with a few exceptions, may not have the technical and financial capacities to invest in digital technologies. It is imperative that the diffusion of these technologies does not merely strengthen large estates, depriving small farmers and small producers of economic value. The measures that one has to take, also in this case, may vary considerably from country to country.

However, I would suggest that cooperative solutions are likely to be needed, where small farmers join forces to use advanced technologies, together with technicians who can help them control this new technology. Now, the local governments need to intervene energetically to finance this initiative, even if necessary on a non-repayable basis. Public authorities need to be sensitized; the public governmental authorities need to act as a catalyser for the use of digital technologies. In this problem, as in the others, it is clear we need a whole panoply of initiatives, that go from the scientific side to the development of user-friendly interface to transfer this knowledge from one country to another; and we need to adopt this new technology locally in such a way that it goes to benefit everybody, not a small minority. And that is a very complex system, and we need everyone's help to go in the right direction.