United Nations Food Systems Summit 2021
Scientific Group Scientific Group
https://sc-fss2021.org/

Food Systems Summit Brief
Prepared by Research Partners of the Scientific Group for the Food Systems Summit
April 2021

The Role of Science, Technology and Innovation for Transforming Food Systems in Latin America and the Caribbean

By Elizabeth Hodson de Jaramillo, Eduardo J. Trigo and Rosario Campos

Abstract

Food systems (FS) incorporate nutrition, health, resource use, biodiversity, transformation, jobs and livelihoods that ideally should be under the concept of the SDGs. The InterAcademy Partnership (IAP) published since 2018 regional and global reports on scientific opportunities and challenges for research on food and nutrition security and agriculture. The Americas report outlined the crucial role of the region as the world's largest net exporter of agricultural products and recognize the circular economy and the bioeconomy as two strategic areas for FS transformation to improve productivity and sustainable use of biological

resources and to reduce waste. The region makes vital contributions to several development objectives, including growth and trade promotion, poverty reduction, food and nutrition security, ecosystem services and climate resilience. There is a substantial diversity in STI capacities among the countries, with many having to confront significant restrictions, particularly with respect to financial and human resources. Nevertheless, significant developments have been made in some countries in biotechnology agricultural applications, conservation and regenerative agriculture and sustainable livestock production systems, as well as young entrepreneurships developing start-ups with impact in the regional bioeconomy. Considering this dichotomy should be an essential component of any strategy to confront the climate change crisis, and the aftermath of the COVID-19 pandemic, that are threatening food supply, nutrition, health and sustainability. The transformation of FS in Latin America and the Caribbean (LAC) with more precision and efficiency requires comprehensive, participatory and inclusive approaches that make full use of current and future scientific advances, including biotechnologies and digital technologies. Those advances are already transforming global agriculture where one is producing more with less, increasing efficiency, and reducing residues. Integration of STI developments and investment opportunities with national and regional policy making is essential, as well as communicating its potential to the public. Specific actions for LAC include: (a) use the great agrobiodiversity of LAC to diversify the FS, thereby increasing nutritional content and climate change resilience and new bioproducts; (b) enable and promote the use of digital technologies in the food value chain: and (c) use beneficial soil microorganisms and the microbiome for sustainable increases in productivity.

1. Introduction

The transformation of Food Systems (FS) can produce huge benefits for health, food security and nutrition, sustainable agriculture and nature. Central to this discussion is the understanding that food systems are demand-led (IFPRI, 2020) and represent the full agri-value chain, which includes growing, harvesting, processing, transporting, marketing, consumption, distribution and disposal of food and food-related items, plus the inputs needed and outputs produced at each of these steps. They integrate nutrition, health, resource use, biodiversity, transformation, jobs and livelihoods that ideally should be under the concept of the SDGs. As an economic complex, they provide close to 1.3 billion jobs and for the livelihoods of over 3.2 billion people around the world. In this sense, transforming FS becomes a key, if not the main issue for making real progress towards all 17 SDGs. by 2030 (UN, 2020). Science, technology and innovation (STI) offer a wide and expanding range of opportunities for making real progress towards these objectives. This paper looks at the involved issues with a focus on Latin America and the Caribbean (LAC).

2. IAP and IANAS reports "Opportunities for future research and innovation on food and nutrition security and agriculture"

The IAP report (2018) emphasizes the urgent need to mobilize financial and human resources to promote the shift towards more efficient and sustainable food systems, an effort which demands profound changes in the way that food is produced, consumed and the resulting waste disposed. Collaboration between the natural and social sciences is required to find sustainable solutions to food systems, as well as an efficient international science advisory mechanism. There is a wide range of scientific opportunities, and making the most of them is a wise public policy decision. Furthermore. all stakeholders must be included along the value chain in an integrated way.

The reports highlight that the transformation of FS requires a coordinated global approach to promote application of research to innovation, connections among disciplines and sectors including cooperation with policies, and enhancement of scientific infrastructure with collaboration between countries, and recognize the circular economy and the bioeconomy as two strategic areas for FS transformation (Lachman et al, 2020; IANAS, 2018). Their main recommendations include: a) Promote substantive changes towards climate-smart food systems. b) Develop incentives for consumers to modify and to improve their diets. c) Reduce food waste. d) Develop innovative foods. e) Increase cooperation between life sciences and social sciences as well as policy research on food, nutrition and agriculture to translate advances into applied innovation. f) Foster international cooperation through advisory mechanisms (IANAS, 2018; IAP, 2018).

3. Food and nutrition aspects, healthy diets

In relation to nutritional aspects, the Americas present a picture of sharp contrast. The region has an exceptional abundance of natural resources, considerable wealth in agrobiodiversity, arable land and availability of water. These constitute major advantages for the future, and make the Americas the largest net food exporter in the world, and the largest producer of ecosystem services. The region makes vital contributions to several development objectives, including growth and trade promotion, poverty reduction, food and nutrition security, ecosystem services and climate resilience. Moreover, aquaculture is emerging as a major industry in a number of countries such as Canada, Chile, Mexico, Peru, Argentina and Ecuador (Morris et al., 2020; IANAS, 2018). However, malnutrition, food insecurity, obesity and other related diseases coexist to a greater or lesser degree throughout the region. There has been a rise in hunger, with the number of undernourished people increasing by 9 million between 2015 and 2019. Food insecurity in LAC went from 22.9% in 2014 to 31.7% in 2019, due to a sharp increase in South America, and over 100 million people cannot afford a healthy diet (FAO, 2020a).

For the transformation to sustainable and healthy diets, the research agenda related to food choices must explore alternative ways of influencing consumer behaviour (IAP, 2018). Among the factors that define healthy diets are availability, affordability, and social and cultural issues. LAC's great agrobiodiversity, and the potential of nutritious, but underutilized or neglected, indigenous crops represent a great opportunity for transformation towards sustainable systems, more balanced diets, and increased resource efficiency and resilience. High diversity in aquaculture in LAC provides wider opportunities for balanced diets (Hodson de Jaramillo et al., 2019).

4. Science and technology and food systems transformation

STI is essential to address the multidimensional nature of food security and food systems. New and emerging technologies in the field of the biological sciences, information and communication, data sciences, artificial intelligence, and associated digital applications are significantly improving the production and productivity of crop and livestock and the quality of food and biomass. Advances in breeding provide means of developing disease tolerant and environmentally friendly varieties of plants and animals. STI also contributes to improved resource use and waste reduction, as well as increasing the overall economic organization and competitiveness of FS. (Basso & Antle, 2020; Saiz-Rubio & Rovira-Más, 2020; ECLAC, et al, 2019; HLPE, 2019; Trigo & Elverdin, 2019; Rose & Chilvers, 2018). In turn, the emerging concept of the circular bioeconomy—keeping renewable components and materials in the system during successive processes while protecting ecosystems using STI—makes it possible to improve productivity and sustainable use of biological resources and to reduce waste. This approach allows the development of new bioproducts with high value-added such as nutraceuticals, biofortified foods, bio-inputs for agriculture, bioenergy and biomaterials for the cosmetic, pharmaceutical, chemical and other industries (Brandao et al., 2021). It generates a range of new services and attaches greater value to biodiversity, for example, integrated pest management based on biological pesticides and fertilizers. It contributes to increase the efficiency of converting biological resource for food, feed, soil health, and other uses by improving biorefinery processes (Trigo et al, 2021, Lachman et al, 2020; ECLAC et al, 2019).

The current STI scenarios for FS transformation offer very concrete opportunities to contribute to the SDGs particularly to: SDG 1 (Reduce poverty), SDG 2 (Reduce hunger), 3 (Good health and well-being), 6 (Clean water and sanitation), 7 (Affordable and clean energy), 8 (Decent work and economic growth), 9 (Industry, innovation and infrastructure), 12, (Responsible production and consumption) , 13 (Climate action), and 15 (Life on land).

These STI scenarios play a key role in the provision of sustainable agricultural development, climate resilient, producing healthy nutritious foods, and guaranteeing global food security. New

developments in agricultural technology will play a leading role in moving our food systems towards more sustainable schemes (Trigo & Elverdin, 2019). Biotechnology has evolved more efficient and faster ways of doing research in breeding programs in agriculture which, combined with digital technologies, potentiate the agricultural advances to produce more with less, which in turn are being proactively reflected throughout the food system (Virginia Tech, 2020).

Global agriculture is undergoing major transformations through the convergence of digital, biological and engineering technologies (ECLAC, 2021; Basso and Antle, 2020; Santos Valle & Kienzle, 2020; Rose & Chilvers, 2018), to optimize agricultural production processes and input utilization in the so-called Agriculture 4.0. The adoption of the new technological strategies must be prudent and based on transparent, inclusive and participatory social processes, adapted to the local conditions, capacities and cultures (ECLAC et al., 2019). To define priorities, the participation of local communities is essential, and should promote a convergence of scientific and traditional knowledge (Herrero et al., 2020). The pace of the innovations can be increased, with the appropriate policies, incentives, regulations and social acceptance (Fanzo et al, 2020).

At the level of specific technologies, the range of possibilities is extremely wide, although two essential concepts stand out: greater precision and efficiency to produce more with less in a sustainable context (ECLAC et al, 2019; Trigo & Elverdin, 2019):

- Rapid and efficient improvement systems, based on the use of genomic information, generational acceleration, and molecular techniques like gene editing.
- Crop sensors connected to mobile devices that allow evaluating input (fertilization, water needs) at precise times and scales.
- Crop health monitoring systems and biological and artificial intelligence mechanisms, which will allow reduction of chemicals in the control of pests and diseases.
- Virtual strategies for the dissemination of management techniques adjusted by locality / region, to significantly increasing the integrated management of crops.
- Livestock biometrics; use of collars and other devices to monitor in real time information about behavior, consumption, and general condition of the animals.
- Precision agriculture, which integrates agroecological and productive information with ICT, proposing management strategies to optimize the use of inputs, including improvements in the efficient use of water and the use of sensors for micro-administration of irrigation.

In addition, there are significant advances in use of beneficial soil microorganisms in agriculture, and the application of the microbiome that can provide higher and more sustainable levels of productivity improvements, food quality and profitability (Singh et al., 2020, FAO, 2019,). Strong international cooperation in microbiome science is essential for achieving efficient microbiome-based innovations (D'Hondt et al., 2021).

5. A perspective from Latin America and the Caribbean

The LAC region is not only a great producer of sustainable biomass, it has become one of the main actors in international markets due to important developments in its scientific-technological capacities, industrial infrastructure and bio energy generation. Several significant technology developments provide a platform of great importance when facing future challenges. These not only include traditional and export crops, but also agricultural biotechnology applications, conservation and regenerative agriculture and sustainable livestock production systems (ECLAC et al., 2019, Trigo & Elverdin, 2019). In biotechnology applications, the region has been one of the early leaders in the adoption of agricultural biotechnology (GM crops) (www.isaaa.org). There are successful public-private initiatives resulting in close to market developments in strategic crops such as soybeans, common beans, potatoes and wheat, and more recently in rice, through the application of gene editing technologies (ECLAC et al., 2019; Oliva et al., 2019).

Another development worth mentioning is the emergence of a new generation of young entrepreneurs, developing technologies and start-ups in several countries (e.g., Mexico, Costa Rica, Colombia, Peru, Brazil, Argentina, and Uruguay). These are beginning to have an impact on the regional bioeconomy landscape, and creating new pathways for scientific effort benefiting the region. A non-comprehensive list include:

- Protera. A Chilean biostartup developing safe, sustainable, and smart protein-based food ingredients with Artificial Intelligence applied to synthetic biology (https://www.proterabio.com/technology)
- Hemoalgae. A Costa Rican biostartup developing high added value chemical compounds using microalgae-based production platforms (http://hemoalgae.com/).
- Nutriyé. A Mexican biostartup developing functional beverages using nutraceutics and natural biological compounds and exploring the potential of personalized nutrition (http://www.nutriye.com/).
- Syocin Biotech. An Argentinian startup developing synthetic biology platforms to redesign and produce biomolecules to target plant bacterial pathogens (http://syocin.com/).
- Sciphage. A Colombian startup developing bacteriophage-based solutions to treat bacterial infections in poultry and reducing the use of antibiotics. (https://sciphage.com/)
- Eficagua. A Chilean biostartup developing solutions to optimize the use of water in agriculture (https://eficagua.cl/).
- Oxcem. A Peruvian biostartup creating microalge-based systems to address air pollution in big cities (https://oxcem.com).
- Scintia. A Mexican biostartup developing innovative tools to make biotechnology and synthetic biology more accessible (https://www.scintia.com/).

In the case of conservationist and regenerative agriculture, reduced tillage practices have been adopted in a wide diversity of production systems (ECLAC et al 2019). There are also important initiatives directed to highlight the strategic character of soils, such as IICA's "Living Soils of the Americas", which seeks to connect public and private efforts in the fight against soil degradation and to maintain the health of cultivated land as well as an efficient management and conservation of soils (https://iica.int/en/press/news/rattan-lal-and-iica-launch-living-soils-americas-initiative). As mentioned crop diversification using local varieties is a strategy to face climate change, improve nutrition and increase resilience (ECLAC et al, 2019).

LAC countries are highly vulnerable to climate change because of their socioeconomic, geographic and institutional characteristics (ECLAC-UNDR, 2021), which is very important for the agricultural sector. Natural disasters such as flooding, storms and landslides are increasing, and several international agencies (UNEP, WFP, CGIAR) are working to promote climate resilience, reforestation and restoration. For instance, the mandate of CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) is to identify and address the most important interactions, synergies and trade-offs between climate change, agriculture and food security. Some results are presented in an Inventory of CSA practices in LAC Climate Smart Villages (Bonilla-Findji et al., 2020). Some studies show that by implementing integrated soil and water management strategies, smallholder family farms can become resilient to climate change (Roop & St. Martin, 2020).

The Caribbean region economies are dependent largely on tourism (ECLAC-UNDR, 2021) and most all the Caribbean countries are net food importers despite having arable lands, rich agrobiodiversity and favorable growing conditions. As agricultural production has been declining in 2018 the Caribbean Community formulated a strategic plan to promote sustainable food production and reduce import dependency through innovation and modernisation of agriculture (https://caricom.org/). The objectives are increased employment, poverty alleviation, reduction in the import bill, food and nutrition security and a reversal of the growing incidence of chronic non-communicable diseases. CARDI will promote the adoption of climate smart agricultural practices by pursuing effective partnerships, capacity building opportunities and information generation and dissemination (CARDI 2018).

The expanding aquaculture industry (the farming of aquatic organisms including fish, mollusks, crustaceans and aquatic plants) can provide more sustainable animal source foods (Gephart et al., 2021) and is contributing to the regional economy through more than 200,000 direct employments and 500,000 indirect ones. In 2018 aquaculture in the Americas produced 3,799,191 tonnes of animal and 21,984 tonnes of plant material (FAO 2020b).

Despite these important developments, the overall picture in the region is one of concern, as a majority of the countries in LAC, particularly the smaller ones, are on

the sidelines. They reflect a substantial diversity among national agricultural research systems, infrastructure, investments in human capital, in financing capabilities and in the roles of public and private sectors in S&T. In terms of investments, five countries (Argentina, Brazil, Chile, Colombia and Mexico) account for more than 90% of the regional investment (Stads et al., 2016). The same trend is observed when investment is presented in terms of a percentage of the countries' agricultural GDP. Only six countries -Brazil, Chile, Anglophone Caribbean, Uruguay, Argentina, Costa Rica and Mexico- invest more than 1% (Stads et.al., 2016). These figures are closely associated with the productivity gaps that are becoming increasingly evident between the region and the rest of the world, and between the tropical and temperate areas (Nim-Pratt el al., 2015). They are also in marked contrast with other countries with relevant agricultural sectors, such as Canada, where investment in agricultural R&D as a percentage of agricultural GDP amounted to 11.3% (2009), or in Australia it exceeded 12.5% (2011) (OECD, 2018).

A similar picture is seen with investments in and capacity for the biosciences. At best, most countries are in the early stages of effectively using new technologies, with significant investments concentrated in a small number of the larger countries, so much of the region's agriculture risks losing the benefits of the new technologies. Close to 90% of total investments and applications in biotechnology in LAC were in Brazil (>50%), Argentina, Mexico, Venezuela, Chile and Colombia (Trigo et al, 2010). This low and concentrated investment levels, is also reflected on the availability of human resources, and issue perhaps more strategic due to the increasing complexity of the situations to be faced. (Stads, et.al, 2016).

6. Lessons from COVID-19

The confinements and disruptive effects caused globally by COVID-19 have demonstrated the enormous fragility of our agrifood systems, stressing the need for FS transformation (UN 2020). The pandemic caused disruptions to global food supply, stressing the crucial importance of LAC as provider of food, and pointed to the need for promoting greater intra-regional economic cooperation, in terms of production, trade and technology (Morris et al., 2020). In this sense, the current crisis is a unique opportunity to change the false claims that economic growth is conflicted with environmental sustainability, and to apply the bioeconomy approach for territorial development with circular systems, and greater resilience for the benefit of society and the planet (Trigo et al., 2021; Lachman et al., 2020). In most LAC countries, FS responded well and was able to continue providing food throughout the crisis, with a rapid emergence of alternatives distribution and marketing systems, through partnerships and the use of the internet (IICA, 2021).

However, as in other parts of the world, the pandemic has triggered recession and declines in income, especially of poor people and due to some disruptions in the food chain vulnerable groups suffered with respect to food security and nutrition . For example, young people in LAC have had difficulty accessing healthy foods

such as fruits and vegetables, compounded by decreased physical activity and increased the consumption of sugary drinks, snacks and fast foods (Leon & Arguello, 2021). The use of Information and Communication Technologies (ICT) and e-trade have grown rapidly. Overall, the insights and lessons from the pandemic should help to design better policies and build more resilient and inclusive food systems for the future. (Swinnen. & Mcdermott, 2020). Looking to the future, a key issue to be confronted will be the fiscal consequences of the COVID-19, as many countries are already making significant cuts into their R&D investments, imposing new restrictions to already poorly financed science and technology systems (IICA, 2021).

7. Moving forward: Strengthening policy in LAC for research and its uptake

Present STI scenarios offer and extensive and strategic set of opportunities and instruments for FS transformation. However, in most cases, existing institutions and orientations reflect past situations and priorities (Morris et al, 2020), and this is a negative factor for effectively mobilizing resources towards transformative Agenda 2030 objectives. Increasing investment levels is a common requirement for all countries, but beyond that, there is an urgent need for institutional structure and organizational approach better reflecting the new environment. The following paragraphs offer some reflections on specific topics and areas of work to consider for this purpose.

The institutional framework for innovation and transfer of agricultural technology: STI alone cannot achieve all the advances in FNS required for the future. Developments, combined with evidence-based policy, must be implemented in the Americas. There is a need for better integration of STI progresses and investment opportunities to national policy making and communicating its potential to the public (IANAS, 2018). R&D institutions should address sustainable whole food systems in an integrated way and along interconnected value chains (HLPE, 2019). Achieving sustainable FS needs the full support of diverse policies: agricultural, trade and exchange, related to resources such as land and water, education and labor, financing and also the ones related to human health and safety, as well as permanent incentives. The goal is to deliver sustainable growth, good jobs, food and nutrition security, and climate-resilient ecosystem services (Morris et al, 2020).

Conventional approaches have resulted in a “silo institutional approaches” (Trigo & Elverdin 2019), which is not the most appropriate to face the complex challenges posed by food system transformation. There is a need to incorporate new actors into the process, and facilitate interaction between biological sciences and other areas of knowledge. There is little tradition of cooperation; therefore, advancing integration mechanisms around common objectives is a priority. Reconfiguring the relationship between scientific research and local knowledge systems is essential for the needed innovative transition

pathways adapted to each type of agricultural and food system (HLPE, 2019).

Work and investment priorities: In general, R&D priorities have been highly focused on solving production problems, improving resource management, and above all in a "short vision" of the agricultural and livestock sector (Stads, et al 2016). The new scenarios demand for a broader agenda, going beyond production to integrate issues related to sustainability, the entire supply chain value, quality, nutrition, energy production and industrial use of biomass (HLPE, 2019). Agriculture and food systems offer opportunities to generate significant numbers of high-quality jobs. It is imperative to direct investment toward sectors that are strategic for the big push, which also have a high potential for job creation (ECLAC, 2021). When technology meets a recognized need and is cost-effective for the intended beneficiary, uptake can be rapid (Fanzo et al, 2020). At the same time, experiential learning and knowledge sharing among practitioners, and co-production of knowledge among multi-stakeholder networks, should be recognized as effective approaches to generate the type of well adapted to the local context innovations that are needed, and to enhance their rapid adoption (HLPE, 2019).

Dealing with the distributional effects of the new scenarios and public policies: Technological change has consequences and effects on the competitiveness of the sector. Innovation must be complemented by policies and actions specifically aimed at ensuring the equitable participation of all sectors involved, particularly those sectors of small-scale family agriculture with restrictions in terms of availability of resources and/or access to infrastructure or services. In this regard, agenda priorities should consider: (i) policies and actions aimed at promoting more equitable access to new technologies (credits, training, development of strategic infrastructures, subsidies to providers of certain technological services, etc.). (ii) the strengthening of national research and development institutions technologies, so that they can be more effective in helping to correct existing market failures affecting equitable access to new technologies.

Improved international cooperation mechanism: The nature of FS calls for an integrated and multi-disciplinary approach including aspects related to the use of natural resources, the adoption of new technologies as well as the issues related to food demand and human behaviour. Policies must respond to local conditions, capacities and cultures and consider the vulnerable groups, but also must be coordinated with global trends (Fears et al, 2020). To take advantage of the transformative potential of technology, it is essential to develop national/regional innovation ecosystems, with the support mechanisms and necessary infrastructure to promote the high levels of agricultural innovation required for the future through the promotion of regional and international cooperation (HLPE, 2019).

For many countries, there are several limitations to access the benefits of new technologies and calls for improved cooperation mechanisms aimed at pooling capacities and technology

sharing. It requires a more complex R&D agenda giving greater importance to basic research in innovation processes, as well as the generalisation (and internationalisation) of protection frameworks for the intellectual property of the new technologies. This is particularly the case for smaller tropical countries, where scale is not only affected by the size of their economies, but also because they often have greater agroecological diversity. In this context, when thinking about future strategy, the question of the size of economies and how that is reflected in capabilities, investment and scale of work of research institutions is an unavoidable issue. Related to this, the construction of solid linkage networks with regional public R&D systems and agricultural extension, and with the private sector, becomes fundamental when it comes to achieving greater efficiencies.

References

BASSO, B., & ANTLE, J. (2020). Digital agriculture to design sustainable agricultural systems. Nature Sustainability, 3(4), 254-256.

BONILLA-FINDJI O, ALVAREZ-TORO P, MARTINEZ-BARON D, LOPEZ C, ÁLVAREZ O, CASTELLANOS A, MARTÍNEZ JD. (2020). Latin America Climate-Smart Villages AR4D sites: 2020 Inventory. Wageningen, The Netherlands: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Available at: https://hdl.handle.net/10568/111398

BRANDÃO, A.S., GONÇALVES, A. &. SANTOS, J.M.R.C.A. (2021). Circular bioeconomy strategies: From scientific research to commercially viable products. Journal of Cleaner Production, 295:126407.

https://doi.org/10.1016/j.jclepro.2021.126407

CARDI –Caribbean Agricultural Research and Development Institute-. (2018). Building a Productive and Resilient Regional Agriculture Sector. Cardi Strategic Plan 2018-2022. Available at: www.cardi.org/wp-content/uploads/downloads/2018/05/CARDI-Strategic-Plan-2018-to-2022-Final.pdf

D'HONDT, K., KOSTIC, T., MCDOWELL, R. *et al.* (2021). Microbiome innovations for a sustainable future. Nat Microbiol **6,** 138–142. https://doi.org/10.1038/s41564-020-00857-w

ECLAC -Economic Commission for Latin America and the Caribbean-. (2021). Building forward better: action to strengthen the 2030 Agenda for Sustainable Development (LC/FDS.4/3/Rev.1), Santiago, 2021. Available at: https://www.cepal.org/sites/default/files/publication/files/46696/S2100124_en.pdf

ECLAC, FAO & IICA. (2019). "The Outlook for Agriculture and Rural Development in the Americas: A Perspective on Latin America and the Caribbean 2019–2020." Available at: https://www.agrirural.org/en

ECLAC-UNDRR (2021). The coronavirus disease (COVID-19) pandemic: an opportunity for a systemic approach to disaster risk for the Caribbean. Available

at: http://www.cepal.org/sites/default/files/publication/files/46732/S2000944_en.pdf

FANZO, J., COVIC, N., DOBERMANN, A, HENSON, S., HERRERO, M., PINGALI, P. & STAAL, S. (2020). A research vision for food systems in the 2020s: Defying the status quo. Global Food Security. 26. 100397. DOI:10.1016/j.gfs.2020.100397

FAO, (2020a). The state of food security and nutrition in the world. Transforming Food Systems for Affordable Healthy Diets. http://www.fao.org/publications/sofi/2020/en/

FAO. (2019). Microbiome: The missing link? Science and innovation for health, climate and sustainable food systems. Available at: www.fao.org/3/ca6767en/CA6767EN.pdf

FAO. (2020b). FAO Yearbook. Fishery and Aquaculture Statistics 2018/FAO annuaire. Statistiques des pêches et de l'aquaculture 2018/FAO anuario. Estadísticas de pesca y acuicultura 2018. Rome. https://doi.org/10.4060/cb1213t

FEARS, R., CANALES HOLZEIS, C. & TER MEULEN, V. (2020). Designing inter-regional engagement to inform cohesive policy making. Palgrave Commun 6, 107 https://doi.org/10.1057/s41599-020-0487-3

GEPHART, J.A.; Golden, C.D.; Asche, F.; Belton, B.; Brugere, C,; Froehlich, H.E.; Fry, J.P.; Halpern, B.S.; Hicks, C.C.; Jones, R.C.; Klinger, D.H.; Little, D.C.; McCauley D.J.; Thilsted, S.H.; Troell, M. & Allison E.H. (2021). Scenarios for Global Aquaculture and Its Role in Human Nutrition. Reviews in Fisheries Science & Aquaculture, 29:1, 122-138, DOI: 10.1080/23308249.2020.1782342

HERRERO, M., Thornton, P., Mason-D'Croz, D., Palmer, J., Benton, T., Bodirsky, B., Bogard, J., Hall, A., Lee, B., Nyborg, K., Pradhan, P., Bonnett, G., Bryan, B., Campbell, B.M., Christensen, S., Clark, M., Cook, M., Boer, I.J.M., Downs, C. & West, P. (2020). Innovation can accelerate the transition towards a sustainable food system. Nature Food:1(5)-266-272. DOI: 10.1038/s43016-020-0074-1

HLPE. (2019). Agroecological and other innovative approaches for sustainable agriculture and food systems that enhance food security and nutrition. A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security, Rome. Available at: www.fao.org/fileadmin/user_upload/hlpe/hlpe_documents/HLPE_Reports/HLPE-Report-14_EN.pdf

HODSON DE JARAMILLO, E., HENRY, G. & TRIGO, E. (2019). La Bioeconomía. Nuevo marco para el crecimiento sostenible en América Latina / Bioeconomy. New Framework for Sustainable Growth in Latin America. Bogotá: Editorial Pontificia Universidad Javeriana. ISBN 978-958-781-378-4. Available at: https://repository.javeriana.edu.co/handle/10554/43705

IANAS. (2018). Opportunities and challenges for research on food and nutrition security and agriculture in the Americas. Regional analysis prepared from country assessments by IANAS. ISBN 978-607-8379-29-3. Available at:

https://www.ianas.org/docs/books/Opportunities_challenges.html.

IAP - InterAcademy Partnership. (2018). Opportunities for future research and innovation on food and nutrition security and agriculture. The InterAcademy Partnership's global perspective. Synthesis by IAP based on the four regional academy network studies. ISBN 978-88-940784-5-9. Available at: www.interacademies.org/publication/opportunities-future-research-and-innovation-food-and-nutrition-security-and

IFPRI. (2020) Global Food Policy Report: Building Inclusive Food Systems. Washington, DC: International Food Policy Research Institute (IFPRI). https://doi.org/10.2499/9780896293670

IICA (2021). La I+D y la transformación del sistema alimentario: una contribución del Instituto Interamericano de Cooperación para la Agricultura (IICA) a la Cumbre sobre los Sistemas Alimentarios 2021 de las Naciones Unidas. Instituto Interamericano de Cooperación para l Agricultura, San Jose Costa Rica (forthcoming)

LACHMAN, J., BISANG, R., DE OBSCHATKO, E.S. & TRIGO, E (2020). Bioeconomía: una estrategia de desarrollo para la Argentina del siglo XXI. Impulsando a la bioeconomía como modelo de desarrollo sustentable: entre las políticas públicas y las estrategias privadas / Instituto Interamericano de Cooperación para la Agricultura. – Argentina: IICA, 2020. ISBN 978-92-9248-899-4.

LEÓN K. & ARGUELLO J.P. (2021). Effects of the COVID-19 pandemic on adolescent and youth nutrition and physical activity Available at: http://www.unicef.org/lac/en/effects-of-covid-19-pandemic-on-adolescent-and-youth-nutrition-and-physical-activity

MORRIS, M; Sebastian, A.R.; Perego,V.M.E.; Nash, J.D.; Diaz-Bonilla, E.; Pineiro, V.; Laborde, D.; Chambers, T.T.; Prabhala, P,; Arias, J.; De Salvo, C.P.; Centurion, M.E. (2020). Future Foodscapes: Re-imagining Agriculture in Latin America and the Caribbean (English). Washington, D.C. World Bank Group. http://documents.worldbank.org/curated/en/942381591906970569/Future-Foodscapes-Re-imagining-Agriculture-in-Latin-America-and-the-Caribbean

NIN-PRATT, ALEJANDRO, CESAR FALCONI, CARLOS LUDENA y PEDRO MARTEL(2015) Productivity and the Performance of Agriculture in Latin America and the Caribbean: From the Lost Decade to the Commodity Boom, IDB Working Papers Series Nº 608, Interamerican Development Bank, Washington DC.

OECD (2018). Agricultural Policy Monitoring and Evaluation 2018. OECD, Publishing, Paris. https://doi.org/10.1787/agr_pol-2018-en

OLIVA, R., JI, C., ATIENZA-GRANDE, G. et al. (2019). Broad-spectrum resistance to bacterial blight in rice using genome editing. Nat Biotechnol 37, 1344–1350. https://doi.org/10.1038/s41587-019-0267-z

ROOP R., ST. MARTIN C.C.G. (2020). Building Climate Resilience of Smallholder

Family Farms by Implementing Integrated Soil and Water Management Strategies in Trinidad and Tobago. In: Leal Filho W., Luetz J., Ayal D. (eds) Handbook of Climate Change Management. Springer, Cham. https://doi.org/10.1007/978-3-030-22759-3_92-1.

ROSE D.C. & CHILVERS, J. (2018). Agriculture 4.0: Broadening Responsible Innovation in an Era of Smart Farming Front. Sustain. Food Syst., 2:87: https://doi.org/10.3389/fsufs.2018.00087

SAIZ-RUBIO, V. & ROVIRA-MÁS, F. (2020). From Smart Farming towards Agriculture 5.0: A Review on Crop Data Management. Agronomy 10, 207. https://doi.org/10.3390/agronomy10020207

SANTOS VALLE, S. & KIENZLE, J. 2020. Agriculture 4.0 – Agricultural robotics and automated equipment for sustainable crop production. Integrated Crop Management Series. Vol. 24. Rome, FAO.

SINGH, B.K., TRIVEDI, P., EGIDI, E. et al. (2020). Crop microbiome and sustainable agriculture. Nat Rev Microbiol 18, 601–602. https://doi.org/10.1038/s41579-020-00446-y

STADS, G.; BEINTEMA, N.; PÉREZ, S.; FLAHERTY, K. & FALCIONI, C. (2016). Investigación Agropecuaria en Latinoamérica y el Caribe. Un análisis de las instituciones, la inversión y las capacidades entre países. ASTI/BID.

SWINNEN, J. & MCDERMOTT, J. (2020). Covid-19 and global food security. EuroChoices 19(3): 26-33. https://doi.org/10.1111/1746-692X.12288

TRIGO E., H. CHAVARRIA, C. PRAY, S.J. SMYTH, A. TORRIBA, J. WESSLER, D. ZILVERMAN, &. J.F. MARTINEZ. (2021)." The Bioeconomy and Food Systems Transformation", FSS Briefs by Partners of Scientific Group. (https://sc-fss2021.org/wp-content/uploads/2021/03/FSS_Brief_Bioeconomy_and_Food_Systems_Transformation.pdf)

TRIGO, E. & ELVERDIN, P. (2019). Los sistemas de investigación y transferencia de tecnología agropecuaria de América Latina y el Caribe en el marco de los nuevos escenarios de ciencia y tecnología. 2030 - Alimentación, agricultura y desarrollo rural en América Latina y el Caribe, No. 19. Santiago de Chile. FAO. 18 p

TRIGO, E., FALCK ZEPEDA, J. & FALCONI, C. (2010). "Biotecnología agropecuaria para el desarrollo en América Latina: Oportunidades y Retos", Documentos de Trabajo LAC 01/10, Programa de Cooperación, FAO/Banco Inter-Americano de Desarrollo, Servicio para America Latina y el Caribe, División del Centro de Inversiones.

UNITED NATIONS, 2020. "Policy Brief: The Impact of COVID-19 on Food Security Nutirtion", United Nations, 2020.

VIRGINIA TECH, 2020. "Productivity in times of pandemics", Global agricultural productivity Report. Executive Summary. College of Agriculture and Live Sciences, Virginia Tech, 2020. https://globalagriculturalproductivity.org

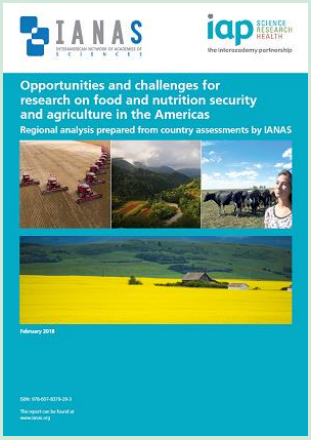
/wp-content/uploads/2019/01/2020-GAP_Report_Exec-Summary-1.pdf

Food Systems Summit Briefs are prepared by researchers of Partners of the Scientific Group for the United Nations Food Systems Summit. They are made available under the responsibility of the authors. The views presented may not be attributed to the Scientific Group or to the partner organisations with which the authors are affiliated.

This Brief was prepared for the UN FSS by updating the IANAS scientific assessment contributed to the IAP project on Food and Nutrition Security and Agriculture.

The authors are:
Elizabeth Hodson de Jaramillo, Emeritus Professor Pontificia Universidad Javeriana, Member of the Colombian Academy of Exact, Physical and Natural Sciences and of the Inter American Network of Academies of Sciences (IANAS). ehodson8@outlook.com
Eduardo J. Trigo, Special Advisor for the IICA Technical Cooperation Directorate. ejtrigo@gmail.com
Rosario Campos, Adviser for the IICA Technical Cooperation Directorate. rosarioscampos@gmail.com

This report presents an update and summarised version of the report *Opportunities and challenges for research on food and nutrition security and agriculture in the Americas.*



For further information about the Inter-American Network of Academies of Sciences (IANAS)
visit **https://ianas.org/**
@IanaSonline

For further information about the InterAcademy Partnership (IAP)
visit **https://www.interacademies.org/**
@IAPartnership