Task Force 4
Digital Transformation

Policy brief

ENHANCING FOOD SUPPLY CHAIN RESILIENCE THROUGH THE UTILISATION OF DIGITAL AND SEQUENCE INFORMATION TECHNOLOGIES

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ABSTRACT

Digitally enabled food value chains and plant breeding programmes can improve resilience to agricultural productivity fluctuations and food insecurity. Digital innovations and economic values unlocked by online genetic data or digital sequence information (DSI) and other digital technologies must maximise positive social and environmental impacts and avoid exasperating global supply chain risks. This brief addresses three policy areas where immediate actions are needed by the G20: first, policy coordination that facilitates the adoption of digital transformations in food value chains; second, the creation of DSI-enabling institutional environments; third, steering basic research funding to encourage multi-disciplinary research that bridges technology, social, and environmental disciplines.

CHALLENGE

The developing and emerging economies of the G20 countries have been active in digital innovations for several years, but in different ways. In the past two decades, global advances in precision agriculture, remote sensing, robots, farm management information systems, and computer-aided decision support systems have paved the way for broad digital transformations in the farming sector and in some parts of food value chains. Recent developments, such as cloud computing, Internet of Things, Big Data, blockchain, drones, and artificial intelligence facilitate the integration of technology development into smart food production and service systems to ultimately enhance resilience. These digital technologies are expected to assist the evolution of the agricultural sector into a data-driven, intelligent, agile and interconnected system involving plant breeders, farmers, processing units, retailers, supermarkets, and end consumers.

Concomitantly, the revolution in genomics and sequencing technologies has led to a greater understanding of evolution, the function of genes and the metabolic processes in which they are involved. These advances have also brought about a sharp decrease in the cost of digitalised genetic information. As more plant genetic and biological data are digitalised and stored in international open databases, plant synthetic biology approaches become available to the scientific community worldwide. This rapid evolution of biological research reduces the need to access plant physical material (e.g. seedbanks), which can be substituted with DSI originating from plants for food and agriculture. Researchers can now readily recreate biological material from genetic information sourced from databases, combine genetic information originally sourced from multiple locations, and modify genetic information to produce completely new plant material. The growing use of DSI has also created increasing international pressure to develop appropriate benefit-sharing protocols. After a decade of international efforts to guarantee the fair and equitable sharing of benefits arising from the utilisation of DSI, virtually nothing has been achieved. A few domestic regulations exist in selected countries that together create a mosaic of DSI policy. This uncertainty discourages information sharing and scientific collaboration.

Covid-19 has irrevocably changed the foundation of information sharing as well as global value chains and services. Embracing digital transformation during the pandemic has increased the resilience of food supply chains by facilitating improved production and business scenario planning, alternative input sourcing channels, and reviews of environmental health and safety practices. However, no enabling mechanisms, partnership frameworks or governance systems have yet been put into place to allow digital transformation to harness its full potential to improve food supply chain resilience, sustainability, and inclusivity.

PROPOSAL

To harness the full potential of DSI and of the digital technologies that promise precision plant breeding and food supply chain resilience, G20 agriculture ministers need to go beyond simply accelerating innovation and instead take a more comprehensive approach. This includes (i) unlocking and scaling agricultural science and technology innovations through coordinated policy actions that improve farm productivity in response to new climate risks and challenges for social inclusion, (ii) building governance structures and policy mechanisms to unlock and harness genetic information on crop plants and benefit-sharing arising from DSI, and (iii) steering basic "Research Funding and Priorities" to encourage multidisciplinary research that bridges technology, social, and environmental disciplines.

In practice, such a comprehensive approach will involve DSI sharing and innovation across global or regional food value chains and collaborating to develop and shape food security at the individual household, national, and regional levels. In addition to broad safeguarding mechanisms and innovation levers, governments and policymakers should take focused steps to support innovation breakthroughs to promote the commercialisation of new plant varieties and technologies that increase the resilience of food value chains. These include targeted research and development (R&D) funding for DSI-based precision breeding, tax incentives for critical digital technologies, innovative public-private financial instruments, technical advisory support for agri-businesses, and facilitation of networks and partnerships amongst plant breeders, entrepreneurs, insurance industries, and large-scale commercial businesses with the know-how to scale up digital innovation for improving supply chain resilience. The G20 meeting of Agriculture Chief Scientists (G20-MACS) should be in a position to implement these recommendations.

RECOMMENDATION 1

Unlock and scale agricultural science and technology innovations through coordinated policy actions that maximise progress towards improved farm productivity in response to new climate risks and challenges for social inclusion. Specific actions to advance this recommendation include:

INCREASE TAX INCENTIVES FOR CRITICAL DIGITAL TECHNOLOGIES

Digital innovations to improve food supply resilience and DSI are often knowledge-intensive, and solutions are more complex and less scalable than current optimisation processes in manufacturing industries and their supply chains (Jakku et al. 2016). Taxes have a distortive effect in the digital supply chain on two levels: firstly, potential disparity in tax burdens imposed on telecommunication operators and providers when compared to other input providers (for example, fertiliser providers, farm machinery); and secondly, taxation asymmetry among global ICT players and domestic players in the agriculture subsector. Governments should examine these asymmetries to determine whether they are a source of distortion and should examine the issue of taxation of digital players in a careful manner. Furthermore, the cost of setting up digital infrastructure is significant. Such costs include not only equipment but also software and skill training (Ehlers, Huber and Finger, 2021). The import duty on digital equipment is also relatively high, in the range of 10-25 % higher than that on agriculture machinery (Adam, 2018). This is arguably the primary reason why digital innovation along the food value chain has been relatively slow and why leading digital technology companies have made few inroads into the food sector and rural areas. To invest in digital value chains, tax credits can potentially be offered to technology providers. When entrepreneurs choose to invest in a particular jurisdiction, consideration ought to be given to the pricing of digital or physical services. Where significant capital expenditure is incurred, value added tax exemptions can be offered for critical digital technologies that have the potential to improve farm productivity and resilience along value chains. On a practical level, technology goods and services that bring environmental benefits such as climate risk reduction could be exempted from customs duty.

GENERATE INNOVATIVE PUBLIC-PRIVATE FINANCIAL INSTRUMENTS

Investments in digital technologies that promote efficiencies such as computing hardware, sensors, high precision GPS and genome mapping tools are invariably offered by established companies that have made significant technology investments (Kamalarisis, 2017). The public sector mandate to provide information and services can be best fulfilled by providing financial incentives to the private sector to add specific territorial context in commercial environments and specific technologies. Public-Private Partnerships in digital agriculture are generally found at the community level where the strengths of the public and private sectors complement one another in providing information and advisory services that address the needs of farmers and rural communities (Aubert et al. 2012). Examples of Public Private Partnership (PPP) models range from establishing digital access points to the generation and delivery of content. Public sector strengths include having a large resource base, setting policies and standards, and generating reliable agricultural information over a wide range of formats/topics. Private sector strengths include capacity for innovation and investment, providing farmer-friendly delivery models in rural value chains that give more choice to farmers and are accountable, and a competitive ability (Capalbo et al. 2017). The G20 should promote national and international PPP initiatives, programmes and funds to unlock and accelerate digital innovations in upstream food value chains.

PROMOTE TECHNICAL ADVISORY SUPPORT FOR AGRI-BUSINESSES

Several contextual conditions will shape the digital transformation of value chains in agribusinesses. Basic conditions required to use technology include availability, connectivity, affordability, ICT in education and supportive policies, and programmes for digital strategies (Anbumozhi, Kimura and Thangavel, 2020; Robertson et al. 2018). Enabling conditions are factors that further facilitate the adoption of technologies, including the use of the internet, mobile phones, social media and digital skills as well as the support of innovation culture such as talent development, including incubators and accelerator programmes. Digital entrepreneurship involves the transformation of existing businesses through novel digital technologies and the creation of new innovative enterprises characterised by the use of digital technologies to improve business operations, the invention of new digital business models, and engaging with customers and stakeholders through new digital channels (Weesink et al. 2018). Globally, there is an increasing number of initiatives to foster digital entrepreneurial activity related to the creation, development, and scaling-up of digital start-ups. A technical advisory at the G20 level should be promoted to consider all aspects of digital farming, from the overall effect on profitability of changing aspects of production to specific advice. Advisory services should give impartial and farm-tailored solutions based on a broad spectrum of specific issues related to digital technologies. Issues covered within the scope of technical advisory services should include agri-business promotion, practices and technology, mitigation and adaptation to climate change, increasing the value of farm products, and diversifying sources of income.

RECOMMENDATION 2

Consolidate governance structures and policy frameworks to unlock and harness online genetic data or digital sequence information (DSI) on genetic resources for food and agriculture. For implementing this recommendation, the following specific actions are proposed:

REACH A CONSENSUS ON THE DEFINITION OF DSI AND PROMOTE IT IN INTERNATIONAL FORA

Technologies enabled by DSI are becoming ubiquitous in life science related research and industry. Food and agriculture are two of the sectors that intensively utilise DSI and technologies or techniques enabled by DSI. Selective breeding, development and characterisation of genetically modified crops, or soil metagenomics are key trends and examples in this regard (Houssen et al. 2020). However, divergent positions on DSI have emerged over the past few years. For some, this signals a new era of open-source gene banks to address global challenges, but to others it threatens a new wave of unjust digital biopiracy (Bond and Scott, 2020). Moreover, “digital sequence information” is acknowledged as a placeholder term for which no consensus or precise definition exists to date, and the lack of a precise definition has impaired international discussion and agreements (Cabrera 2020; Kobayashi et al. 2020). Few domestic measures on DSI are in place. Worldwide, 16 countries have now introduced national measures to regulate DSI and 18 are preparing to do so. The absence of a unified approach could discourage information sharing and collaboration amongst the scientific community, particularly from the Global South (Ambler et al. 2020; Karger et al. 2020). To tackle this, the G20 countries should establish technical working groups to advance an agreed definition of DSI and clarify its potential scope. This would also alleviate the polarisation of positions. At the same time, the G20 should promote international discussions on the governance of DSI to harmoniously improve regulatory frameworks. The Convention of Biological Diversity, the World Health Organisation, the International Treaty on Plant Genetic

Resources for Food and Agriculture, the Commission on Genetic Resources for Food and Agriculture, and the UN Convention on the Law of the Sea are the main multilateral organisations where deliberations on DSI implications are in place. Hence, G20 countries should advocate its agreed DSI definition and position in these international fora.

ENABLE POLICY FRAMEWORKS TO MAKE STRATEGIC DATA AVAILABLE TO SPECIFIC USERS

International evidence suggests that the development and ownership of digital systems and data has led to a concentration of knowledge, power, and revenue (Eastwood et al. 2012; Barnes et al. 2019). The cost of digital infrastructures, such as telecommunications, security protocols, ledgers, clouds, etc. and the advantage of accumulated data tend to favour big actors and first movers in the development of new digital technologies, while creating barriers to new entrants (Van Es and Woodard 2017). Robust public policy frameworks and regulatory systems are needed in this regard to ensure that huge information and power asymmetries do not hurt consumers and impede the digital transformation of food and agriculture value chains. G20 governments should employ a joined-up approach to digital transformation within their countries, including the provision of inter-departmental oversight across government functions to ensure that hardware and data are managed in a non-discriminative way. Because DSI generation emphasises the need to ensure data preservation, the G20 should establish resource and capacity enhancement mechanisms to ensure globally standardised infrastructure for the sustainable long-term storage of nucleotide sequence databases while preserving digital rights and patents and avoiding the non-consensual use of plant genetic information.

RECOMMENDATION 3

Steer basic “Research Funding and Priorities” to encourage multidisciplinary research that bridges technology, social, and environmental disciplines. The following specific actions are needed:

INVEST IN TARGETED RESEARCH AND DEVELOPMENT (R&D) FUNDING FOR DSI-BASED SELECTIVE BREEDING

Science is a global endeavour and the ability to tackle complex global challenges depends on international collaboration and the ability to share and freely access research findings and data (Smyth et al. 2020). In this sense, the widespread sharing of DSI is fundamental for advancing research and driving innovation (Aubry et al. 2020), particularly to leverage crop genetic diversity for meeting current challenges in food and agriculture. The G20 should mobilise resources for increasing the diversification of plant genetic resources. For instance, genome editing research and new breeding techniques based on DSI can foster the development of new crop varieties to improve the sustainability and resilience of agriculture (Halewood et al. 2018). This recommendation builds upon the agreement of G20 Agriculture Ministers made in 2018 (MACS, 2018). The CGIAR Research Centres, a global partnership that unites international organisations engaged in research on food security are already active in this research. Currently, best available estimates indicate that increasing the CGIAR budget al one would go halfway to decreasing global hunger by 2050, as well as generating a multiplicity of other human and environmental benefits (Rosegrant et al. 2017).

COLLABORATE TO DEVELOP AND SHAPE FOOD SECURITY AT THE INDIVIDUAL HOUSEHOLD, NATIONAL, AND REGIONAL LEVELS

Digital technological innovations including DSI along the value chain can be at the core of improving efficiency in crop prediction, aggregation, quality assurance, logistics and marketing, thus reducing cost, enhancing connectivity, and contributing to food security. The development of digital strategies and their alignment with other government plans for food security at the household and regional levels will enable new technologies and services to be implemented with greater coordination and synergies (Wolfert et al. 2017; Xin and Taueta 2016). Facilitating effective coordination between Ministries, especially those overseeing Agriculture, Communication and Information Technology, and Rural Development, is a step forward in identifying key challenges and implementing multidisciplinary research contributing to a strategic road map for providing digital solutions and food security at national levels. The role of the private sector as value-added service producers, innovators, and incubators is also important.

SUPPORT BREAKTHROUGH DEVELOPMENTS AND INNOVATIONS TO PROMOTE THE COMMERCIALISATION OF NEW PLANT VARIETIES AND TECHNOLOGIES THAT IMPROVE FOOD VALUE CHAIN RESILIENCE

In addition to the above broad mechanisms and levers, governments and policymakers can also take several direct steps to support breakthrough innovations and promote commercialisation. Fostering innovation ecosystems is important with respect to the supply side of digital solutions. In addition, innovation hubs always lower the entry and establishment costs for new competitors (Griffin et al 2017). Further, commercialisation of new plant varieties and technologies that improves resilience requires the reduction of private sector investment risks, which could be achieved by strengthening digital property rights and patent protection, providing stable agricultural policy regimes, and encouraging equity or venture capital financing. With respect to increasing demand for technologies, the creation of laws and regulations strengthening data security, privacy and ownership rights, and transparent protocols for data collection, storage and processing are prerequisites (Steinke et al 2020). Effective strategies to strengthen digital knowledge and skills development include promoting digital literacy amongst farmers, providing digital extension and advisory services to enable farmers and small-sized enterprises to undertake online transactions and linking them through e-platforms for the use of digital technology solutions.

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